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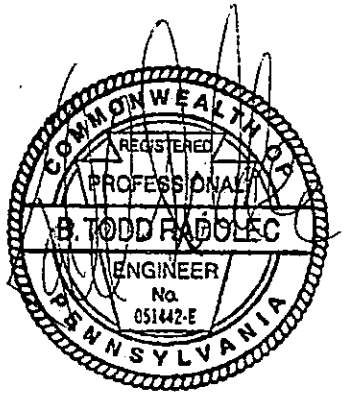
NEMACOLIN WOODLANDS RESORT CASINO

TRAFFIC IMPACT STUDY

Wharton Township, Fayette County, Pennsylvania

December 2005

Prepared for:
NWL COMPANY
1001 LaFayette Drive
Farmington, PA 15445



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2. Chapter 201 Engineering and Traffic Studies, Title 67 of the Pennsylvania Vehicle Code, Transportation, Pennsylvania Department of Transportation, December 1993.

3. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 1997.

4. A Policy on geometric Design of Highways and Streets, 1990, American Association of State highway and Transportation Officials.

5. ITE Trip Generation Manual 7th Edition.

6. PennDOT Publication 282.

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ABSTRACT

On behalf of NWL Company, McMillen Engineering has performed a traffic impact study for the proposed Casino at Nemacolin Woodlands Resort.. The project includes the converting the existing Woodlands Outdoor World into a Class 3 (resort) casino with 500 slot machines. Intersection analysis was performed for the main intersections along the Route 40 corridor from SR 381 to Dinner Bell Road. The project is located in Wharton Township, Fayette County, Pennsylvania.

The objective of this study is to analyze the impact of building conversion on the existing Route 40 Corridor. Base traffic data was compiled from counts conducted by McMillen Engineering during the weekday of August 12 – 13, 2005. This data was used to determine the capacity of the existing roads/ intersections and formed the basis for the recommended improvements.

Traffic analysis has been performed for weekday peak PM and Saturday peak hour traffic volumes for the opening day (2006) and future (2016) design years. All intersections shall operate at an adequate level of service to accommodate design volumes with the proposed roadway improvements. Recommended improvements resulting from the traffic impact study are as follows.

1. **Route 40 / Casino Main Driveway**
   - Install medium volume signalized driveway with left turn lanes for both Route 40 approaches.

I. INTRODUCTION

On behalf of NWL Company, McMillen Engineering performed a traffic impact study for the proposed casino at Nemacolin Woodlands Resort. The project includes converting the existing Woodlands World into a Class 3 resort casino with 500 slot machines. Intersection analysis was performed for the main intersections along the Route 40 Corridor from SR 381 to Dinner Bell Road. The project is located in Wharton Township, Fayette County, Pennsylvania. The general influence area is based on a 30-mile radius from the site which contains five county areas of population outlined in Table 1.

The objective of this study is to analyze the impact of proposed development on the existing Route 40 corridor. This study has been conducted in accordance with PennDOT Publications 282 and traffic impact study guidelines established by the Institute of Transportation Engineers (ITE).

II. BASE TRAFFIC ANALYSIS

A. Study Area and Site Location

The project site is located in Wharton Township, Fayette County, Pennsylvania. The project site is described in Section II. B below. The project scope includes the analysis of the SR 0040 corridor from SR 381 to SR 2011 (Dinner Bell Road). The site is shown on the site location map (Figure 1). The study area for the analysis is shown on Figure 2.

The study area includes the existing seven (7) major intersections of SR 0040 and the proposed driveways at the site.

The existing intersections analyzed for this traffic impact study is as follows:

Route 40/SR 381 S
Route 40/SR 381 N
Route 40/Hawes Road
Route 40/Secondary Driveway
Route 40/Casino (main) Driveway and Marker Road
Route 40/Smith School Road
Route 40/SR 2011 (Dinner Bell Road)

B. Proposed Development

Proposed development consists of converting the existing 54,000 square-foot Outdoor Store Retail Facility into a 500 slot machine casino. The facility shall be governed by the Pennsylvania Gaming Control Board regulations currently under development. The development components of the proposed development are outlined in Table 2.

TABLE 1 AREA POPULATION DATA	
City / County	2000 Census*
Uniontown	12,422
Fayette	148,644
Westmoreland	369,993
Washington	202,897
Greene	40,672
Somerset	80,023

*2000 census population (critical) used in traffic distribution calculations.

TABLE 2 DEVELOPMENT COMPONENTS TRAFFIC IMPACT STUDY		
ITE Number	**Development Component**	**Description**
473	Casino	500 slots
815	Outdoor Store	54,000 sf

TABLE 3

PROJECTED TRIP GENERATION

NEMACOLIN WOODLANDS RESORT CASINO

Wharton Township, Fayette County, Pennsylvania

Prepared by: McMillen Engineering Inc.

PROJECTED VEHICLE TRIP GENERATION (1)

				Weekday Peak PM Hour (3)			Saturday Peak Hour (4)		
Development Component	Size	ITE Code (5)	Average Weekday Daily Traffic (2)	Enter	Exit	Total	Enter	Exit	Total
Casino	500 slots	473		155	140	295	170	150	320
Outdoor Store	54,000sf	815	3000	148	147	295	208	201	409

(1) Trip generation rates based on Institute of Transportation Engineers, Trip Generation Manual 7th edition and Information provided by PADOT 12-0.

(2) Average weekday daily traffic volumes projected to be generated during a typical weekday (total trips entering and exiting)

(3) Trips shown for weekday PM peak hour of generator. The projected trips are applied to the peak hour of adjacent street traffic.

(4) Trips shown for saturday peak hour of generator. The projected trips are applied to the peak hour of adjacent street traffic.

(5) ITE land use code from Institute of Transportation Engineers, Trip Generation Manual 7th edition

C. Traffic Analysis

SPC has projected traffic growth of 1% based upon projected growth of adjacent developments for the surrounding areas. Base trip data was compiled by McMillen Engineering on August 12 – 13, 2005. Manual counters were utilized to obtain movement counts along the SR 0040 corridor See Appendix 1 for traffic count data. Computer analysis was performed utilizing the HCS Release 4.1d. The scenarios analyzed in the study are as follows:

1 2006 Weekday Peak PM Hour Base Conditions
2 2006 Saturday Peak Hour Base Conditions
3 2006 Weekday Peak PM with Development Conditions
4 2006 Saturday Peak Hour with Development Conditions
5 2016 Weekday Peak PM Hour Base Conditions
6 2016 Saturday Peak Hour Base Conditions
7 2016 Weekday Peak PM Hour with Development Conditions
8 2016 Saturday Peak Hour with Development Conditions

The analysis considers the Weekday PM Peak and the Saturday Peak hour traffic volumes, turning movement data collection, projections of the future development, intersection capacity analysis and left-turn warrant evaluation and safety considerations. Based upon these parameters, findings of the analysis are listed in the following section.

Figures 4 and 5A-B outline the transportation plan and the distribution of the generated traffic.

D. Traffic Impact Study Findings

The following approach levels of service (LOS) were observed for each study intersection.

1. **SR 0040 /SR 0381 S**
   LOS E- Weekday PM peak hour 2006 conditions without development
   LOS E- Weekday PM peak hour 2006 conditions with development
   LOS D- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS F- Weekday PM peak hour 2016 conditions without development
   LOS F- Weekday PM peak hour 2016 conditions with development
   LOS E- Saturday peak hour 2016 conditions without development
   LOS E- Saturday peak hour 2016 conditions with development

2. **SR 0040 / SR 0381 N**
   LOS D- Weekday PM peak hour 2006 conditions without development
   LOS D- Weekday PM peak hour 2006 conditions with development
   LOS E- Saturday peak hour 2006 conditions without development
   LOS D- Saturday peak hour 2006 conditions with development
   LOS E- Weekday PM peak hour 2016 conditions without development
   LOS E- Weekday PM peak hour 2016 conditions with development
   LOS F- Saturday peak hour 2016 conditions without development
   LOS E- Saturday peak hour 2016 conditions with development

3. **SR 0040 / Hawes Road**
   LOS C- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS D- Weekday PM peak hour 2016 conditions without development
   LOS D- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

4. **SR 0040 / Secondary Driveway**
   LOS -- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS -- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS -- Weekday PM peak hour 2016 conditions without development
   LOS C- Weekday PM peak hour 2016 conditions with development
   LOS -- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

5. **SR 0040 / Casino (main) Driveway and Marker Road**
   LOS B- Weekday PM peak hour 2006 conditions without development
   LOS B- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS B- Saturday peak hour 2006 conditions with development
   LOS C- Weekday PM peak hour 2016 conditions without development
   LOS B- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS B- Saturday peak hour 2016 conditions with development

6. **SR 0040 / Smith School House Road**
   LOS C- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS C- Weekday PM peak hour 2016 conditions without development
   LOS C- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

7. **SR 0040 / SR 2011 (Dinner Bell Road)**
   LOS D- Weekday PM peak hour 2006 conditions without development
   LOS D- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS E- Weekday PM peak hour 2016 conditions without development
   LOS E- Weekday PM peak hour 2016 conditions with development
   LOS D- Saturday peak hour 2016 conditions without development
   LOS D- Saturday peak hour 2016 conditions with development

III. EXISTING TRANSPORTATION SYSTEM

A. Traffic Impact Study Area

The study area considers the SR 0040 Corridor between SR 0381 and SR 2011. It encompasses seven (7) existing un-signalized intersections and one proposed signalized intersection.

B. Existing Road Network

SR 0040 runs east and west with the majority of the traffic from the adjacent developments traveling the corridor. Local roads will have minimal trips and minimal affect from the proposed conversion of the existing facility into the casino.

C. Existing Traffic Volume Peak Hours

Data was collected for turning movements in the study area during Friday and Saturday peak hours. The study considers the weekday PM and Saturday peak periods.

TABLE 4
PEAK HOUR SUMMARY

Intersection	Peak Weekday PM	Peak Saturday PM
All	4:45 – 5:45	10:45 – 11:45

D. *Improvements Proposed by Others*

At this time no roadway improvements are proposed for the SR 0040 Corridor within the study area. A Needs Study is being considered to upgrade SR. 0040 from SR 0381 to SR 2011.

E. Traffic Signal Warrant Analysis

The need for a traffic signal at a particular intersection is based upon criteria in Chapter 201, Engineering and Traffic Studies[2], of the Pennsylvania Code, Title 67, under traffic Signal Warrants, Signalization is based on factors such as traffic volumes, vehicular movements, capacity analysis, speed data, and accident analysis. One or more of the traffic signal warrants must be met to justify a traffic signal.

A traffic signal warrant analysis has been performed for the intersection. The site driveway does warrant a traffic signal.

Results of the Warrant Analysis are presented in Appendix 8.

F. Highway Capacity Analysis

The Highway Capacity Manual[3] defines capacity analysis as a set of procedures used to estimate the traffic-carrying ability of a facility over a range of defined operational conditions. The operations conditions are described in terms of a letter from "A" to "F" with "A" being the most desirable

condition. A description of the various levels of service is outlined in the Highway Capacity Manual.

The level of service at signalized intersections measures the average stop delay time per vehicle and also the volume to capacity ratio as it relates to the specific intersection. The capacity ratio compares the peak hour traffic volumes to the theoretical maximum traffic volumes that the facility can accommodate.

The level of service for an un-signalized intersection measures the delay to turning traffic to find a gap in a major street traffic flow to allow for the successful completion of the desired turning movement. The critical movements at un-signalized intersections are left turns on the main streets and left turns on the side streets.

Capacity analyses were performed for the weekday PM and Saturday Peak periods at the study intersections. The capacity analysis results are provided in detail in Appendix 2 through 5.

Capacity analyses were performed for 2006 and 2016 weekday peak PM and Saturday peak periods. Results of the analysis are compared for base and developed conditions. Summaries of the traffic volume and levels of service are presented in Figures 6-9 and Table 5.

G. Queue Analysis

See Appendix 7 for the queue analysis for the left turn lanes to be added as a result of this development.

H. Peak Hour Factors

Peak hour factors were calculated for the weekday PM and Saturday peak hours of traffic volume. The peak hours are based upon the peak fifteen minute volumes observed for each of the peak hour periods. Calculations are provided in Appendix 6.

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.1	A/9.6
Approach		
SR 381S Northbound		
Left and Right Turns	E/37.8	D/27.7
Approach	E/37.8	D/27.7

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.0	A/9.4
Approach		
SR 381S Northbound		
Left and Right Turns	E/36.4	C/24.9
Approach	E/36.4	C/24.9

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/8.9	A/8.9
Approach		
SR 381N Southbound		
Left and Right Turns	D/29.0	E/35.5
Approach	D/29.0	E/35.5

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/8.9	A/8.7
Approach		
SR381N Southbound		
Left and Right Turns	D/29.5	D/29.8
Approach	D/29.5	D/29.8

TABLE 5
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ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.5
Approach		
Hawes Road Southbound		
Left and Right Turns	C/20.9	C/20.9
Approach	C/20.9	C/20.9

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.3
Approach		
Hawes Road Southbound		
Left and Right Turns	C/20.6	C/19.3
Approach	C/20.6	C/19.3

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs		
Approach		
Secondary Driveway Southbound		
Left and Right Turns		
Approach		

TABLE 5
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ROUTE 40
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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.2
Approach		
Secondary Driveway Southbound		
Left and Right Turns	C/15.1	C/15.1
Approach	C/15.1	C/15.1

TABLE 5
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ROUTE 40
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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Westbound		
Left Turns and Throughs	A/8.8	A/9.0
Approach		
Marker Road Northbound		
Left and Right Turns	B/14.3	C/16.0
Approach	B/14.3	C/16.0

TABLE 5
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ROUTE 40
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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Eastbound		
Left Turns	C/31.1	C/31.5
Right Turns and Throughs	B/16.2	B/14.7
Approach	B/17.9	B/17.0
Route 40 Westbound		
Left Turns	C/28.6	C/28.5
Right Turns and Throughs	B/13.4	B/12.9
Approach	B/13.7	B/13.2
Marker Road Northbound		
Left, Right Turns and Throughs	C/24.3	C/24.2
Approach	C/24.3	C/24.2
Main Driveway Southbound		
Left Turns	C/25.2	C/25.3
Right Turns and Throughs	C/25.1	C/25.2
Approach	C/25.2	C/25.3
Entire Intersection LOS	B/17.0	B/16.4

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITHOUT-DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.4
Approach		
Smith School Road Southbound		
Left and Right Turns	C/15.3	C/17.5
Approach	C/15.3	C/17.5

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.2	A/8.5
Approach		
Smith School Road Southbound		
Left and Right Turns	C/15.1	C/18.7
Approach	C/15.1	C/18.7

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.3	A/8.2
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.8	A/8.8
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/27.8	D/33.8
Approach	D/27.8	D/33.8
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	D/31.9	C/24.9
Approach	D/31.9	C/24.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.3	A/8.1
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.7	A/8.7
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/27.2	D/30.3
Approach	D/27.2	D/30.3
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	D/31.2	C/23.0
Approach	D/31.2	C/23.0

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.4	B/10.0
Approach		
SR 381S Northbound		
Left and Right Turns	F/59.3	E/38.0
Approach	F/59.3	E/38.0

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITH DEVELOPMENT
ROUTE 40
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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.3	A/9.8
Approach		
SR 381S Northbound		
Left and Right Turns	F/56.6	D/32.9
Approach	F/56.6	D/32.9

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
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Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/9.2	A/9.1
Approach		
SR 381N Southbound		
Left and Right Turns	E/41.6	F/53.3
Approach	E/41.6	F/53.3

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INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITH DEVELOPMENT
ROUTE 40
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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/9.1	A/8.9
Approach		
SR381N Southbound		
Left and Right Turns	E/41.3	E/42.2
Approach	E/41.3	E/42.2

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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.6	A/8.7
Approach		
Hawes Road Southbound		
Left and Right Turns	D/25.9	C/24.7
Approach	D/25.9	C/24.7

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	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.5	A/8.5
Approach		
Hawes Road Southbound		
Left and Right Turns	D/25.6	C/22.8
Approach	D/25.6	C/22.8

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs		
Approach		
Secondary Driveway Southbound		
Left and Right Turns		
Approach		

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.6
Approach		
Secondary Driveway Southbound		
Left and Right Turns	C/16.5	C/18.7
Approach	C/16.5	C/18.7

TABLE 5
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2016 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Westbound		
Left Turns and Throughs	A/9.0	A/9.3
Approach		
Marker Road Northbound		
Left and Right Turns	C/15.2	C/17.1
Approach	C/15.2	C/17.1

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Eastbound		
Left Turns	C/31.1	C/31.5
Right Turns and Throughs	B/18.6	B/16.3
Approach	B/19.8	B/18.1
Route 40 Westbound		
Left Turns	C/28.6	C/28.6
Right Turns and Throughs	B/14.2	B/13.5
Approach	B/14.5	B/13.8
Marker Road Northbound		
Left, Right Turns and Throughs	C/24.3	C/24.2
Approach	C/24.3	C/24.2
Main Driveway Southbound		
Left Turns	C/25.2	C/25.3
Right Turns and Throughs	C/25.1	C/25.3
Approach	C/25.2	C/25.3
Entire Intersection LOS	B/18.3	B/17.2

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.6
Approach		
Smith School Road Southbound		
Left and Right Turns	C/16.7	C/20.0
Approach	C/16.7	C/20.0

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.5
Approach		
Smith School Road Southbound		
Left and Right Turns	C/16.4	C/18.9
Approach	C/16.4	C/18.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.4	A/8.4
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/9.0	A/9.0
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	E/35.3	E/48.4
Approach	E/35.3	E/48.4
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	E/44.4	D/31.8
Approach	E/44.4	D/31.8

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.4	A/8.3
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.9	A/8.9
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/34.6	E/41.8
Approach	D/34.6	E/41.8
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	E/42.8	D/28.7
Approach	E/42.8	D.28.7

IV. DESIGN CONDITIONS

A. Design Year and Assumptions

The future year of 2016 was selected as the design year based upon the PaDOT policy of designing improvements for ten years beyond the proposed development. Additional assumptions include the traffic growth rate, current Transportation Improvement Program (TIP) items, and traffic volumes generated by other developments in the study area or close vicinity.

The traffic growth rate was obtained from the Southwestern Pennsylvania Regional Planning Commission (SPC).

B. Left-Turn Lane Analysis

The need for left turn lanes at each of the study intersections were evaluated based on the criteria proved in the Intersection Channelization Guide, NCHRP Report 279, published by the Transportation Research Board. The proposed site driveway meets the requirements of a left turn lane.

C. Development Scenarios on Proposed Roadway Improvements

The recommended roadway improvements outlined in Section IV D and shown in Figure 3 were developed based on projected full development.

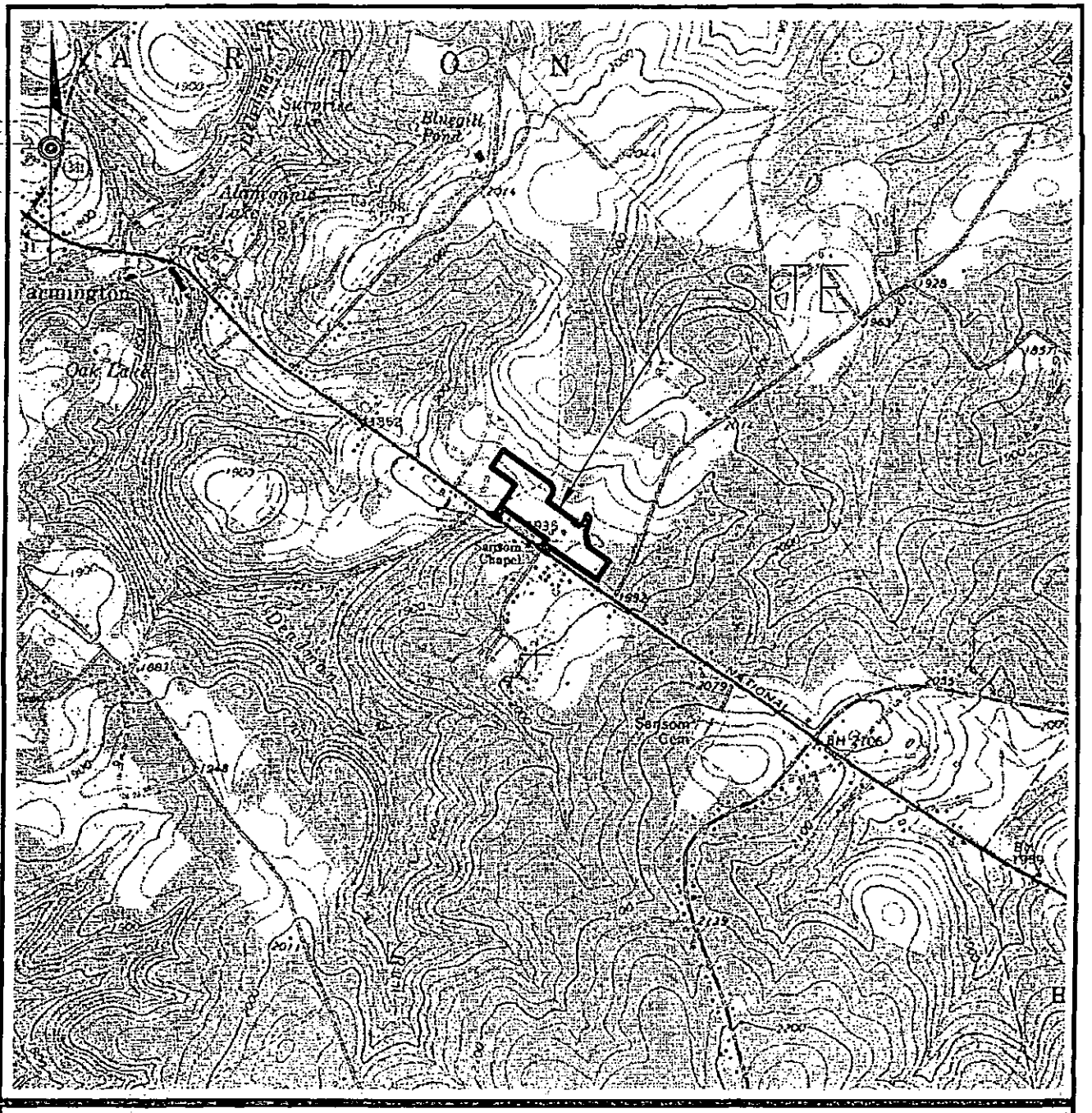
Final roadway improvement details will be determined as part of final development and design.

D. Recommendations

McMillen Engineering recommends the improvements to the corridor as outlined in the analysis and this report. The improvements include:

1. **SR 0040 / Casino (Main) Driveway**
   - Install medium volume signalized driveway with left turn lanes for both Route 40 approaches.

FIGURES



QUADRANGLE: FORT NECESSITY, PA SCALE: 1"=2000'

FIGURE 1

USGS LOCATION MAP

NWL - OUTDOOR STORE RENOVATION

Wharton Township Fayette County

Pennsylvania

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Phone (724) 439-8110

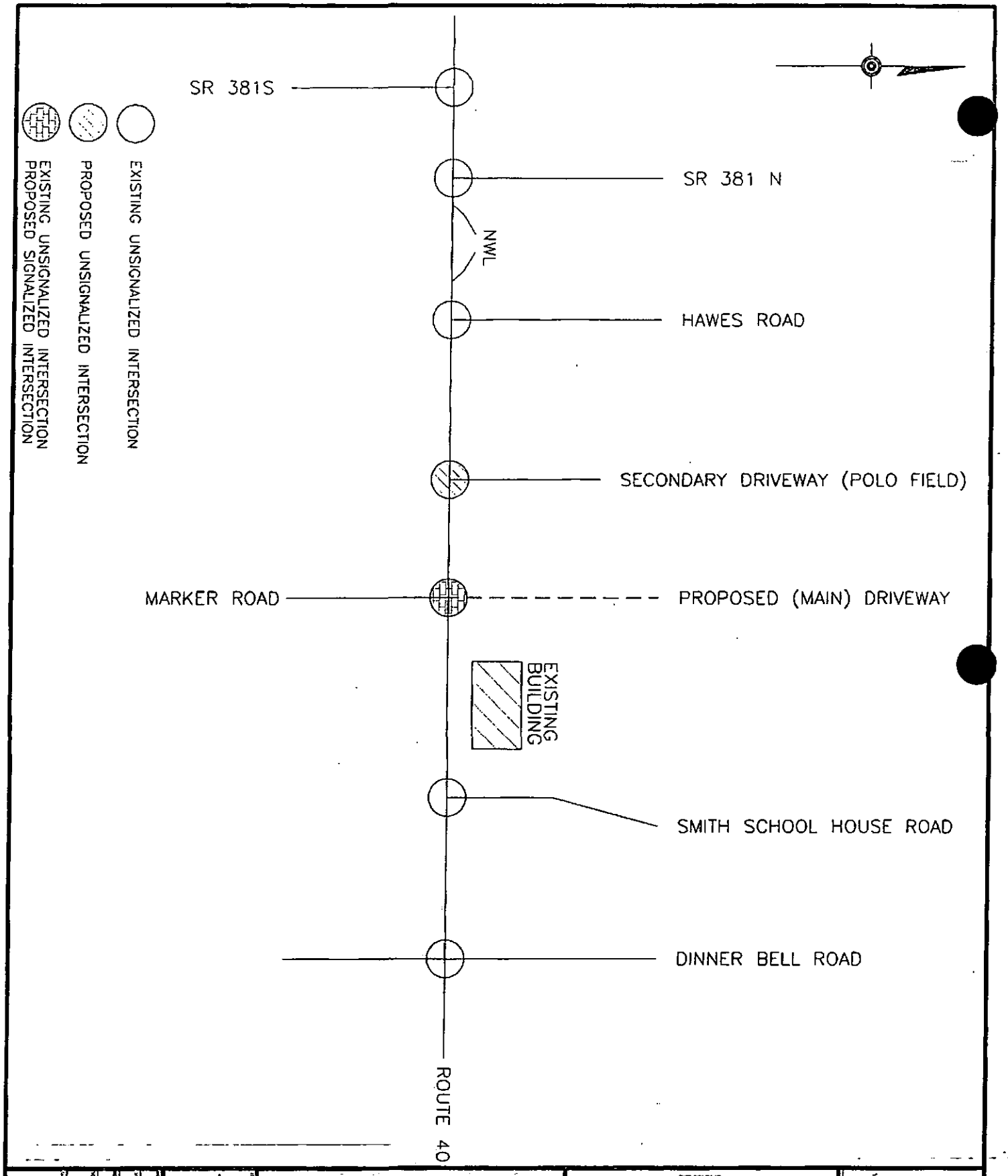

FIGURE 2

TRAFFIC ANALYSIS AREA MAP

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE RENOVATION

PREPARED FOR

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APPROVED	12/01/05		

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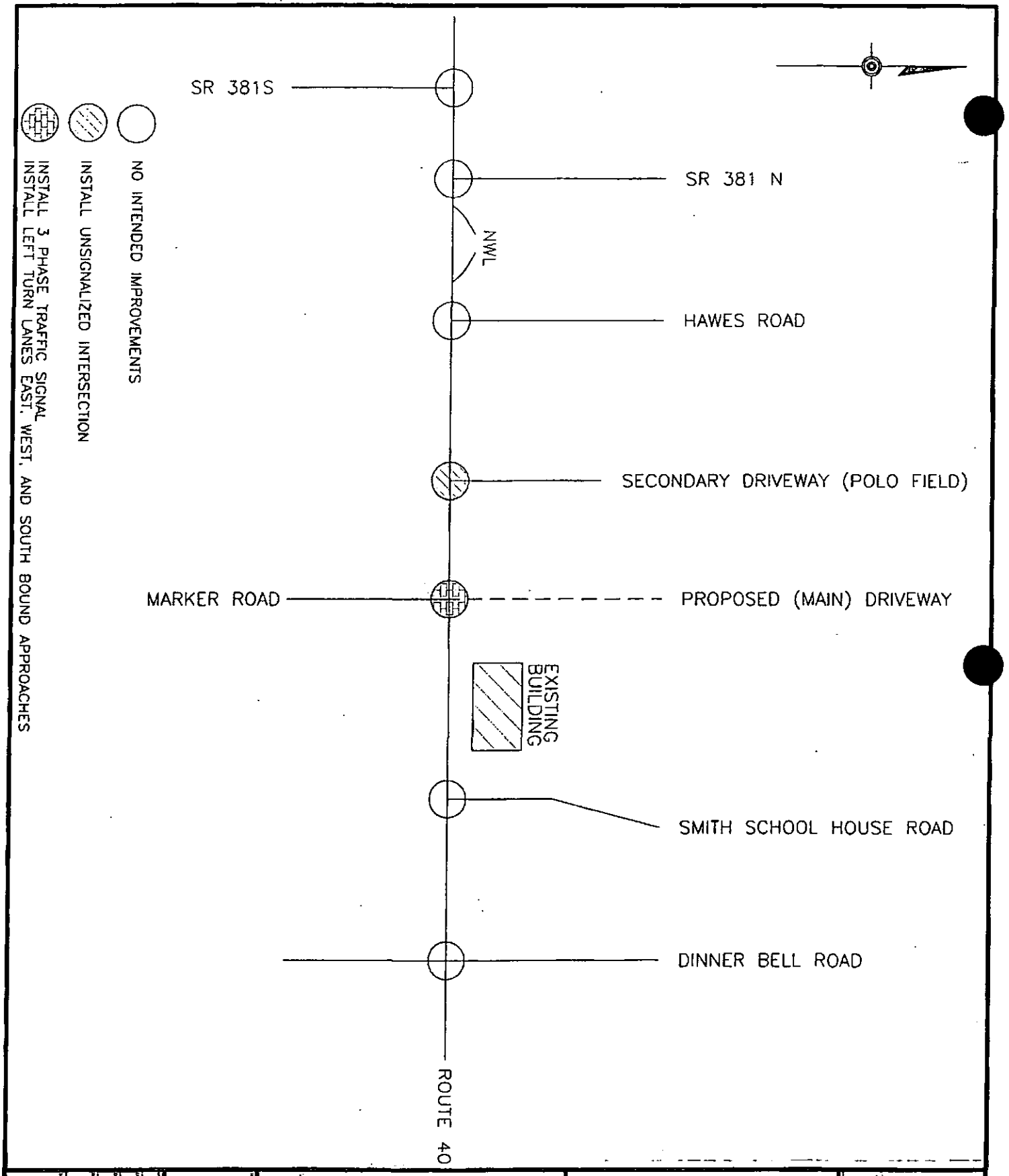

FIGURE 3

N.T.S.

RECOMENDED IMPROVEMENTS MAP

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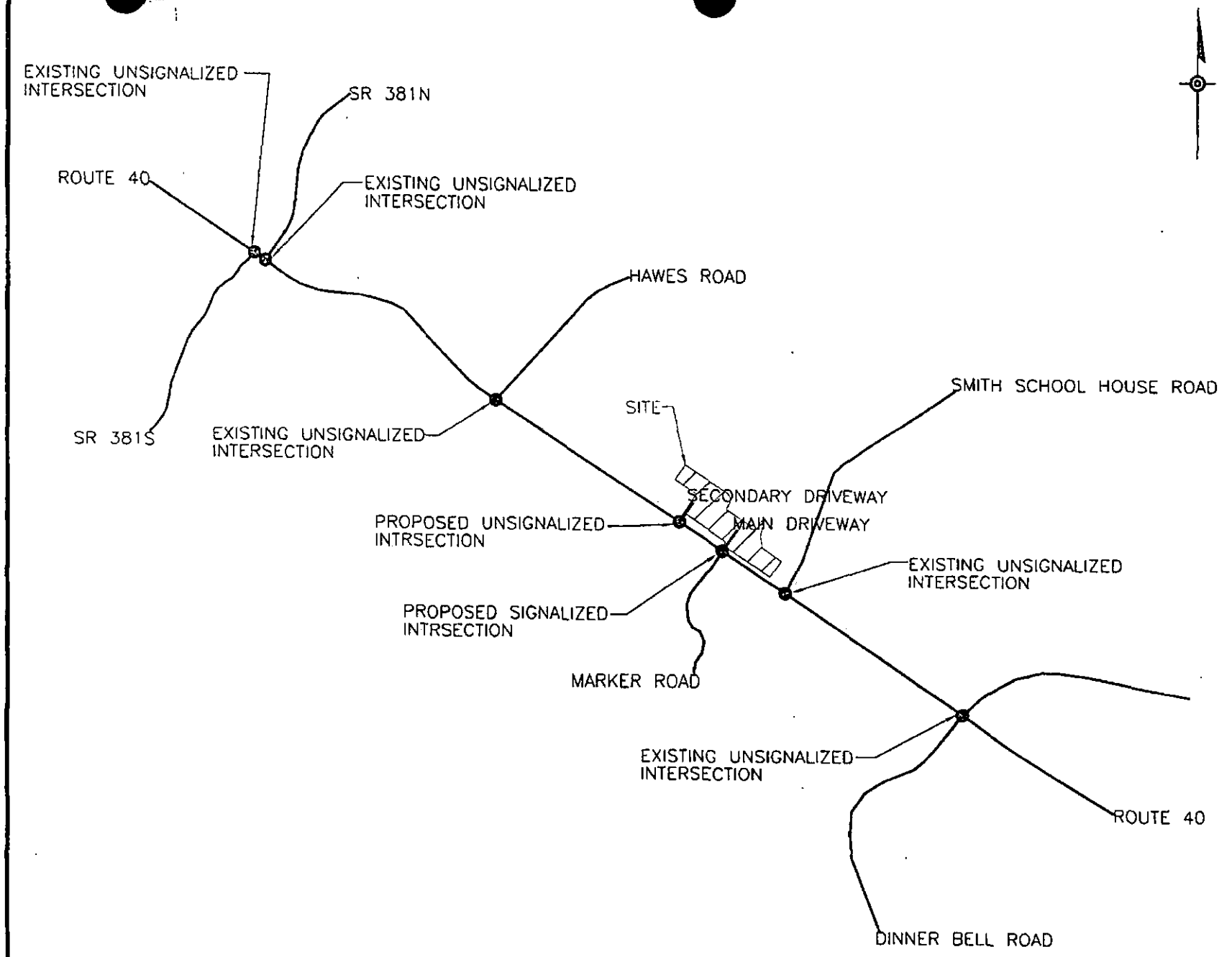

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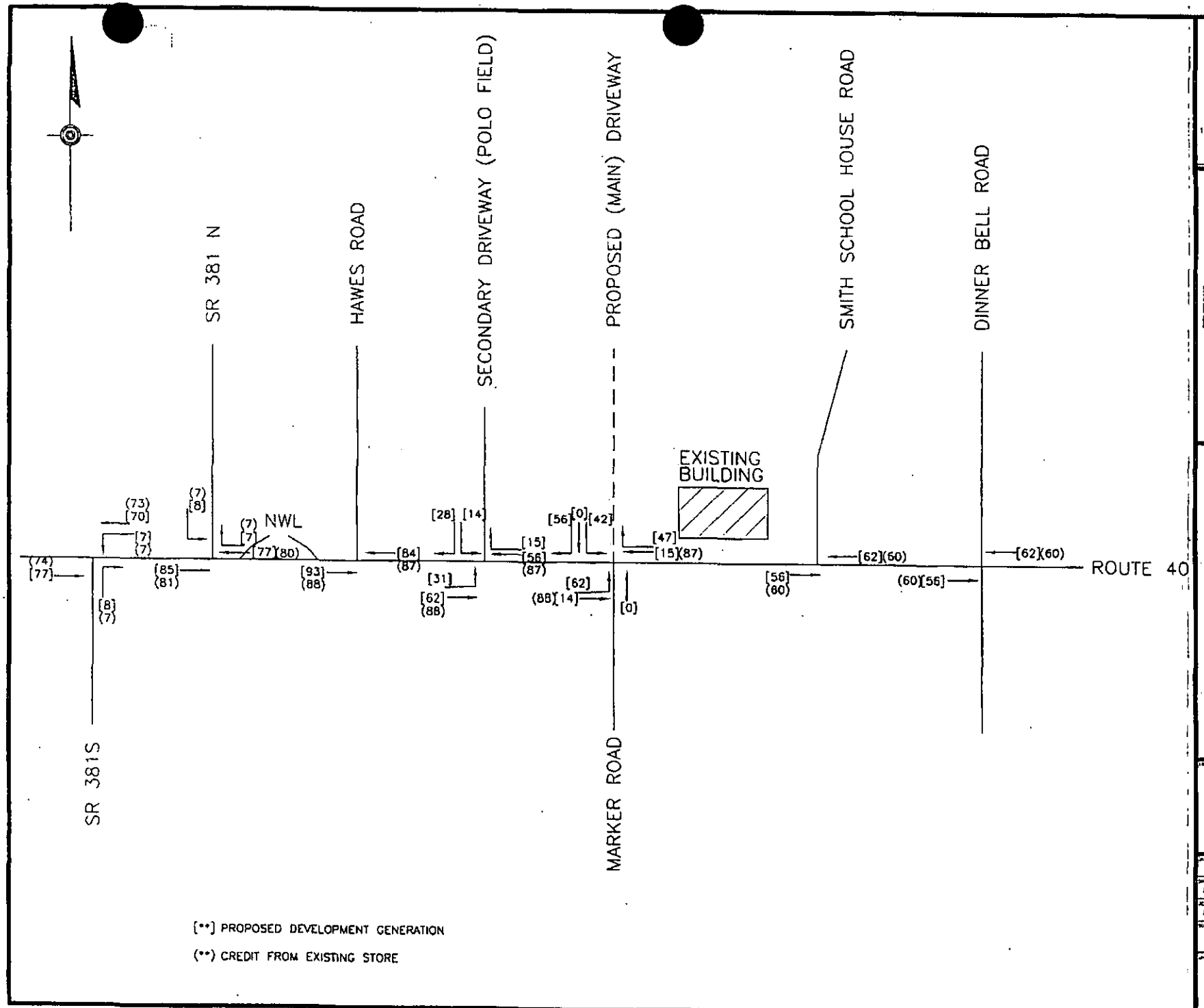
TITLE

TRANSPORTATION PLAN

JOB NO.	--	JOB NO.	2005-319
DESIGN	RHN 11/23/05	DRAWN	TR 11/23/05
CHECK	RHN 11/23/05	APPROVED	* --
SCALE	N.T.S.		
SHEET NUMBER	FIGURE 4		



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NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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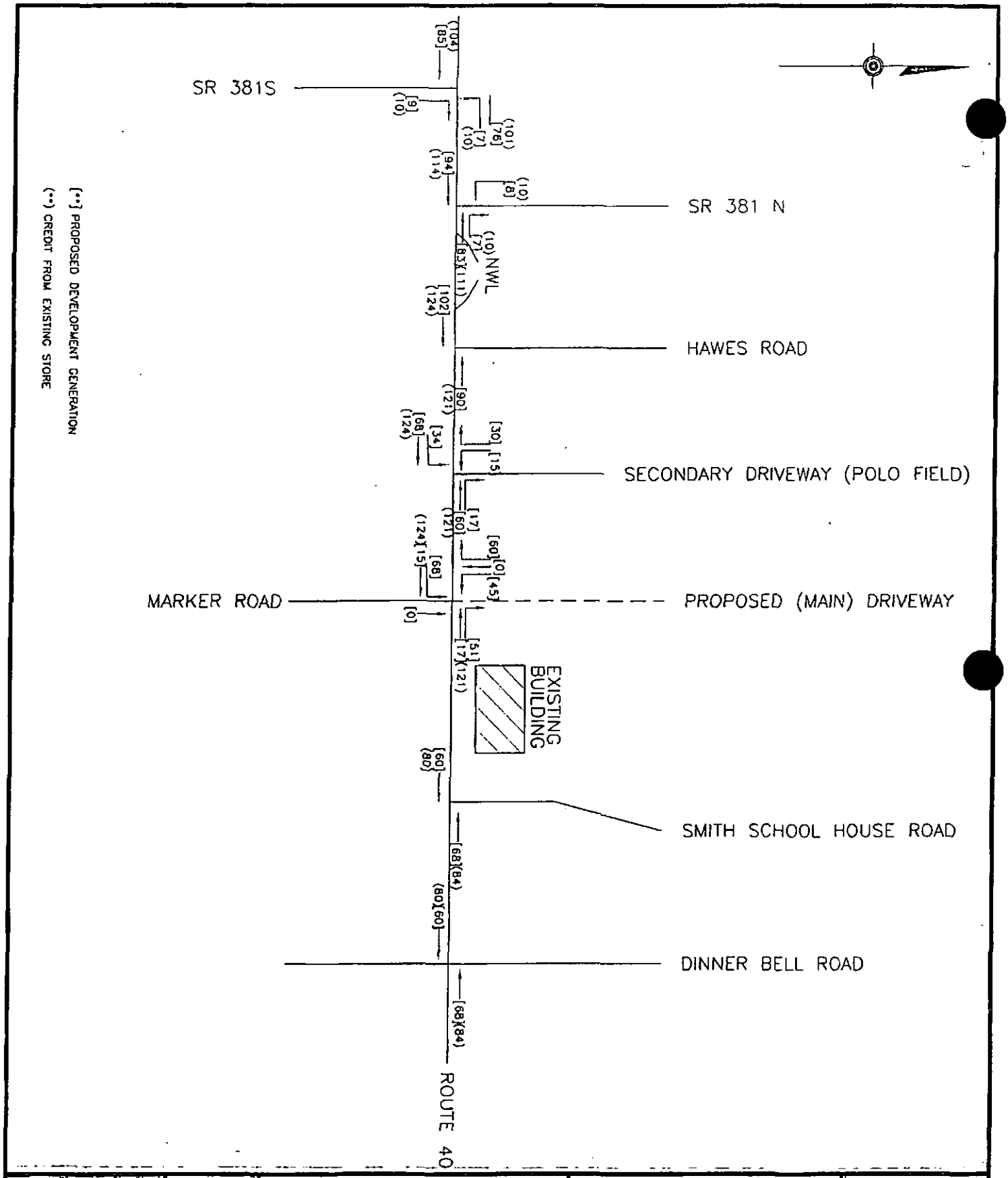
WEEKDAY PM
DISTRIBUTION MAP

		JOB NO.	2005-318
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **

SCALE: N.T.S.

FIGURE 5A



NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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SATURDAY DISTRIBUTION MAP

FIGURE 5B

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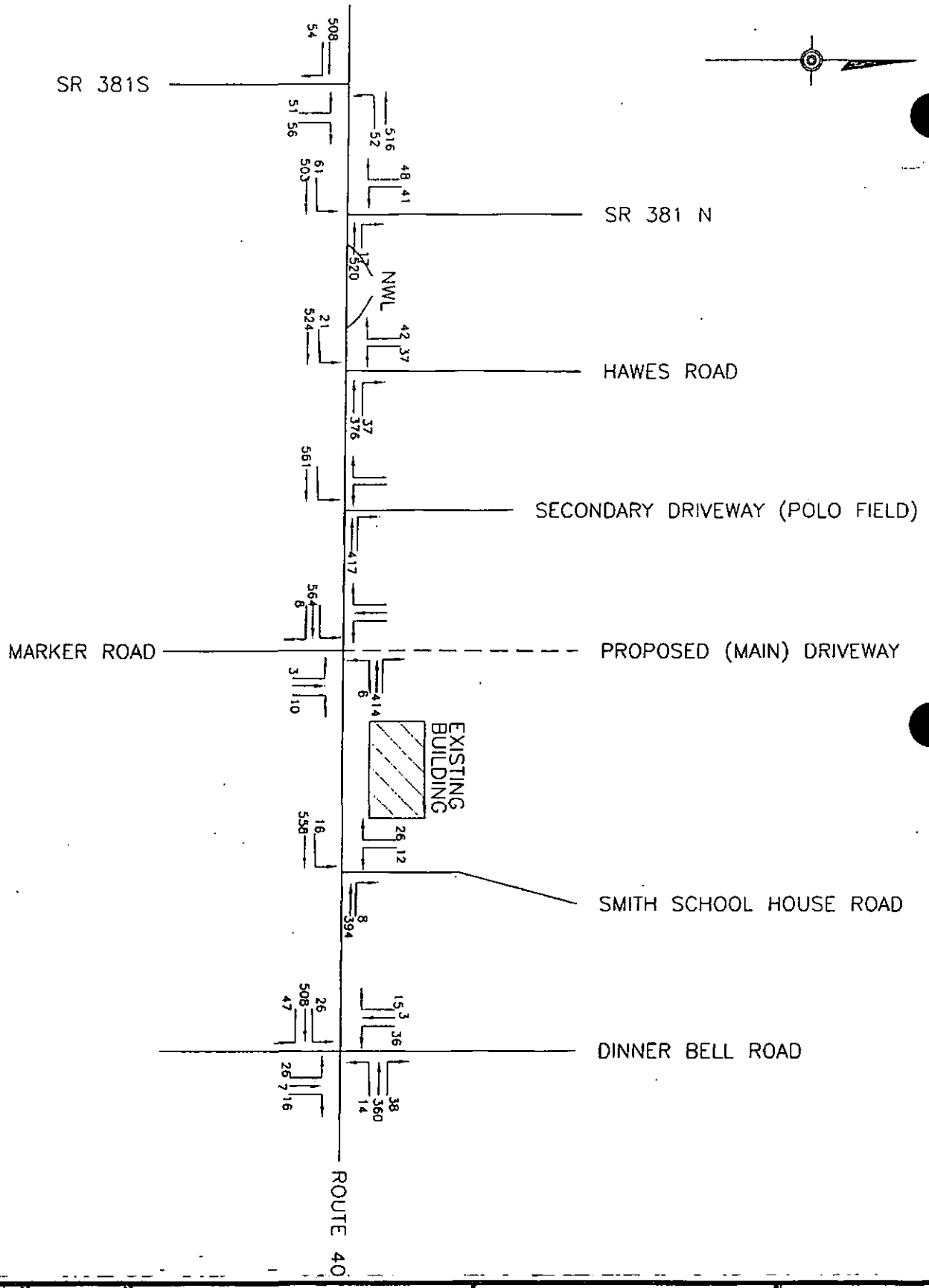

FIGURE 6A

2006 WEEKDAY PM PEAK HOUR BASE VOLUMES

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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CHECKED	TR	11/23/05
SCALE	N.T.S.	
JOB NO.	2005-319	

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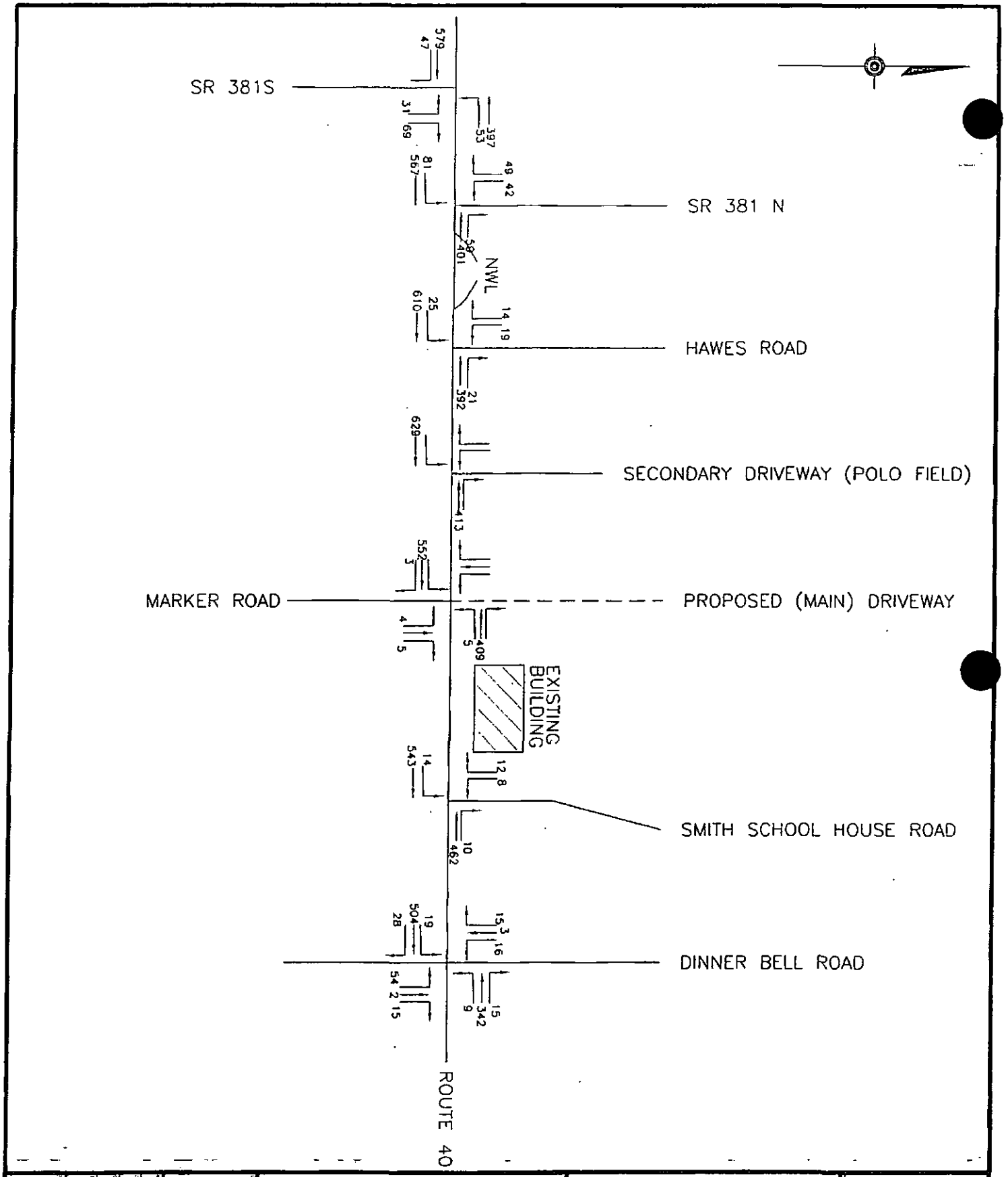

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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2006 SATURDAY PEAK HOUR BASE VOLUMES

FIGURE 6B

N.T.S.

	DRAWN	DATE	JOB NO.
**	RMH	11/23/05	2005-319
**	CHECKED	TR	11/23/05
**	APPROVED	*	**

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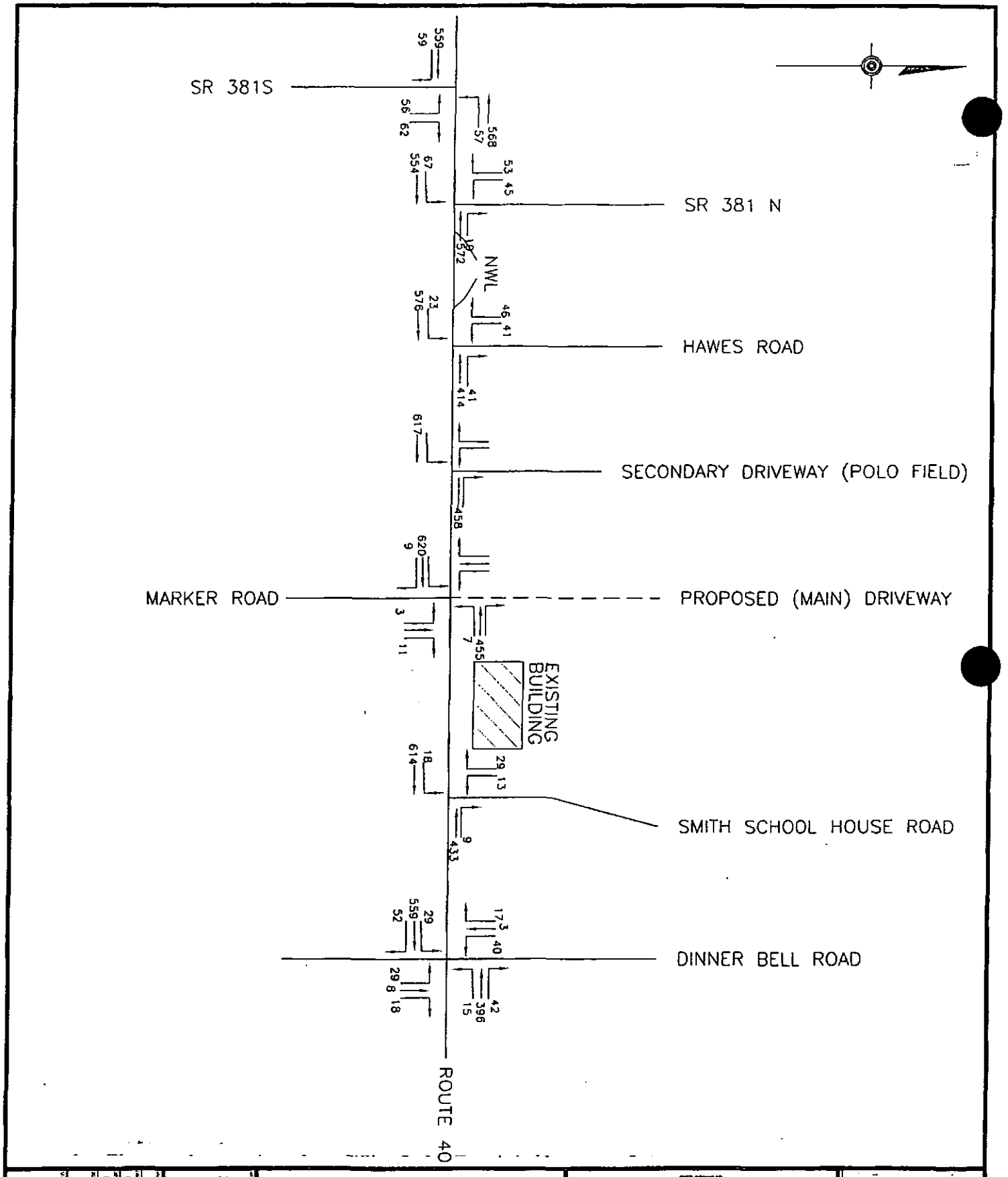

FIGURE 6C

2016 WEEKDAY PM PEAK HOUR BASE VOLUMES

N.T.S.

DRAWN	RMH	11/23/05	
CHECKED			
SCALE	N.T.S.	11/23/05	
JOB NO.	2003-319		

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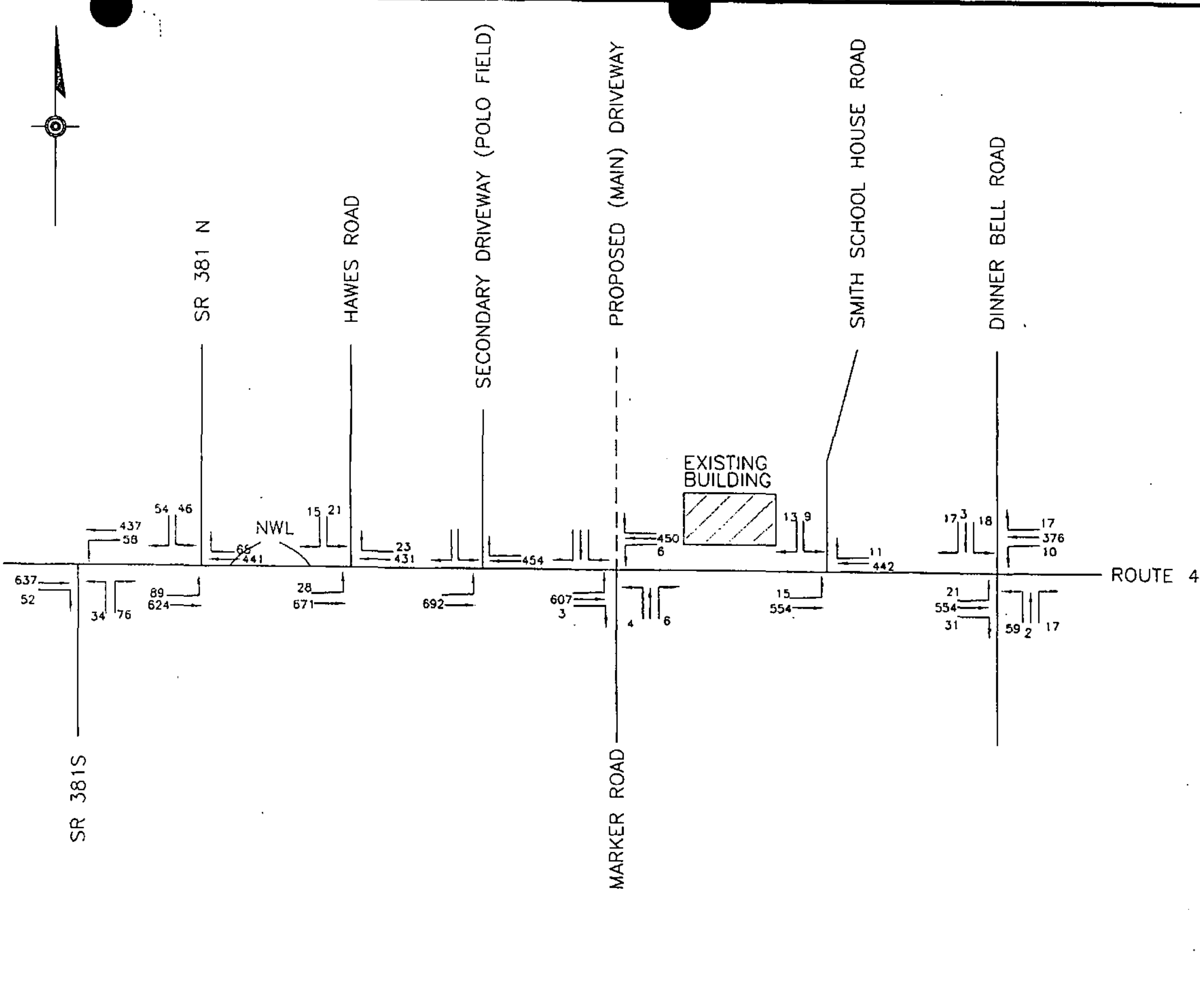

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2016 SATURDAY PEAK HOUR BASE VOLUMES

**	2005-319
RHH 11/23/05	TR 11/23/05
RHH 11/23/05	* **

N.T.S.

FIGURE 6D

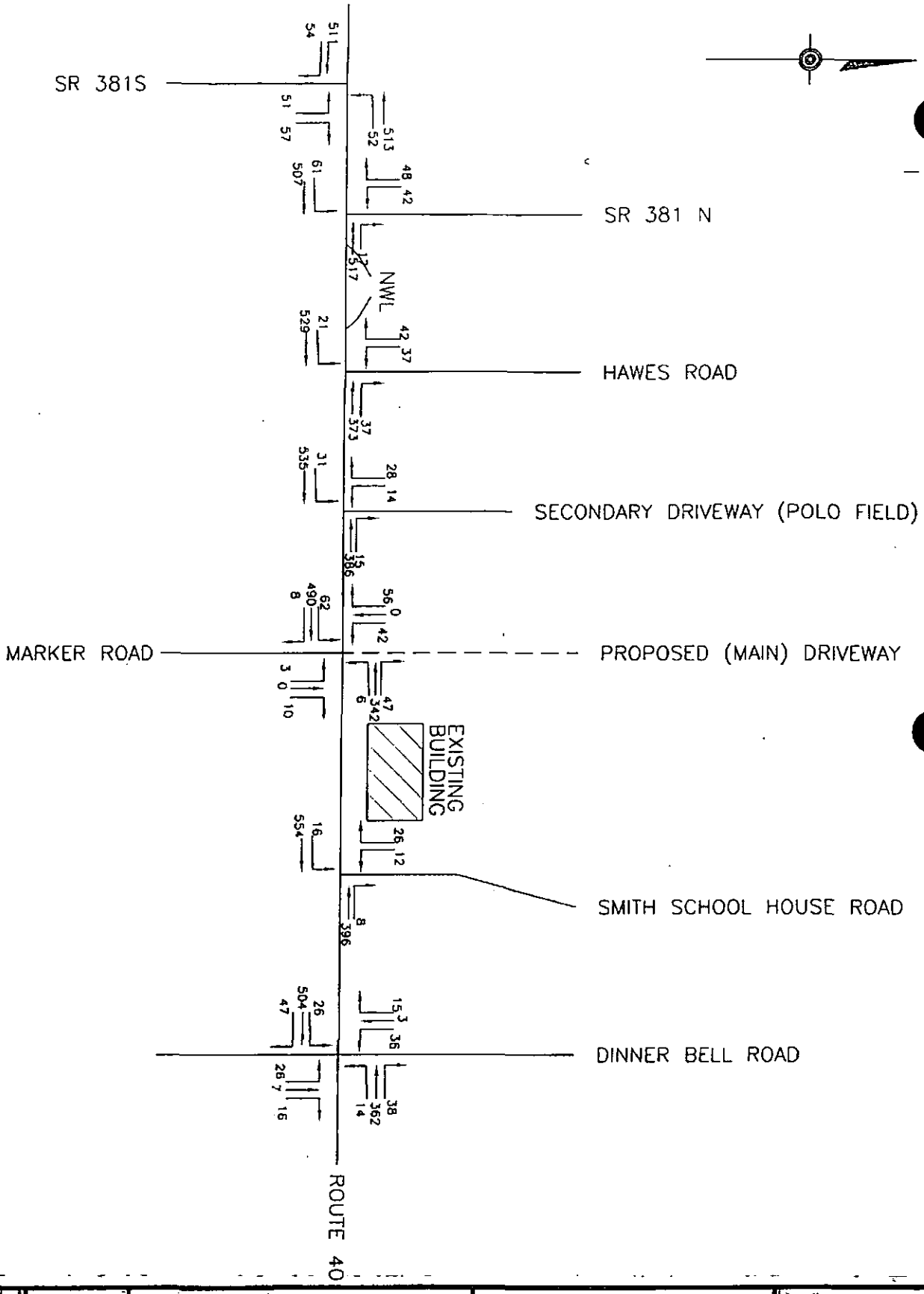

FIGURE 7A

2006 WEEKDAY PM PEAK HOUR DEVELOPED VOLUMES

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JOB NO.	2005-318		

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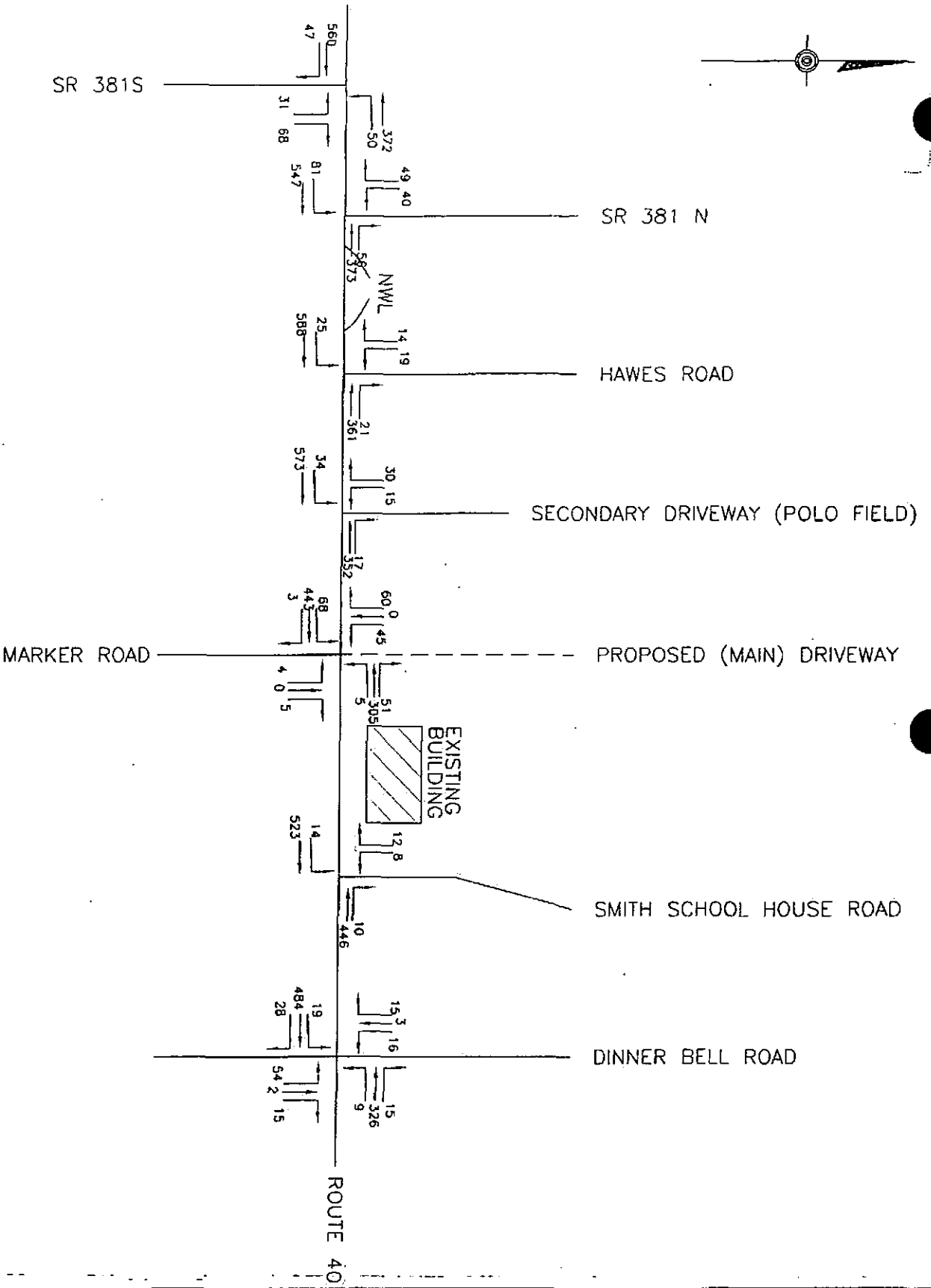

FIGURE 7B

2006 SATURDAY PEAK HOUR DEVELOPED VOLUMES

NEMACOLIN WOODLANDS RESORT

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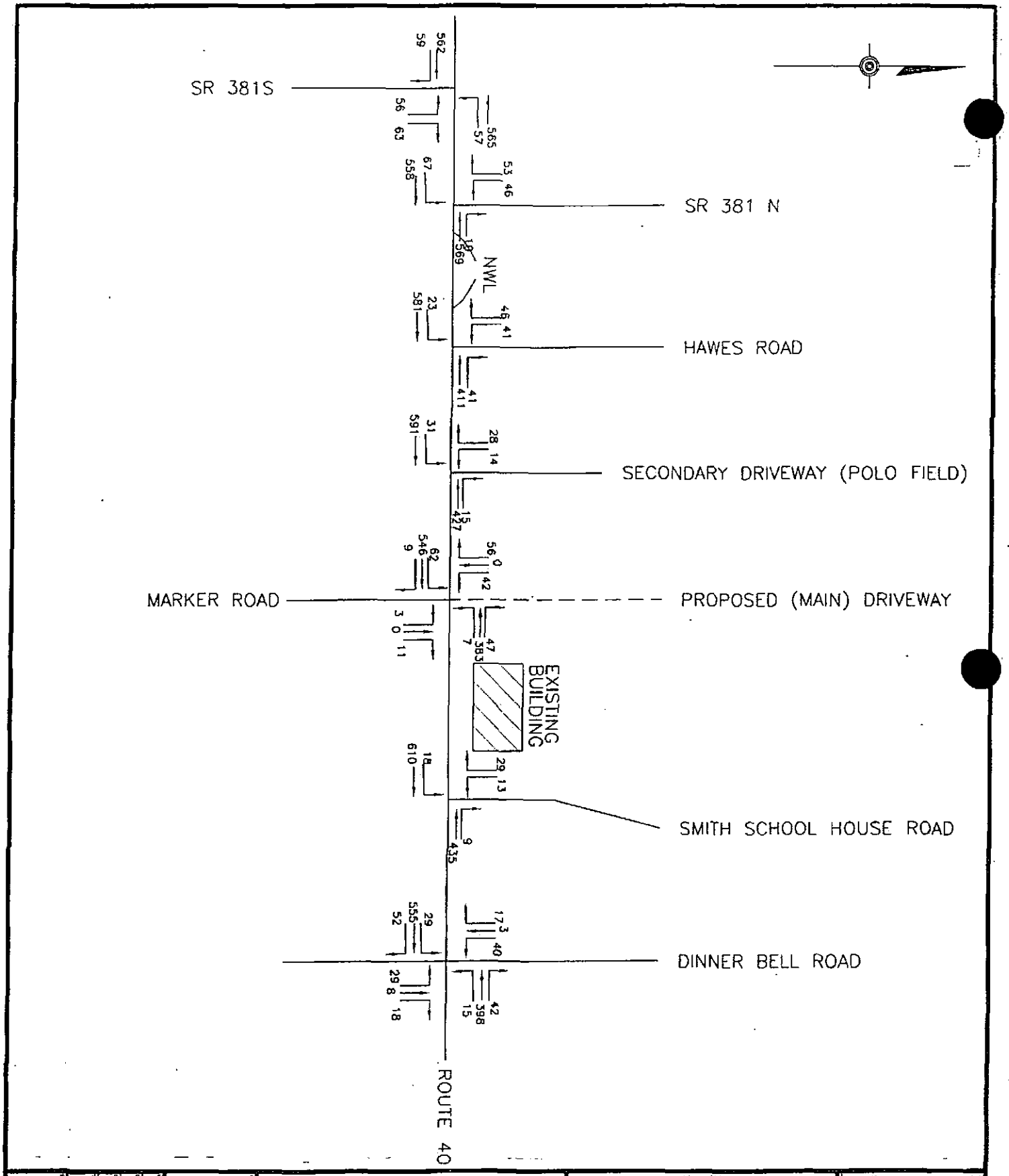

FIGURE 7C

2016 WEEKDAY PM PEAK HOUR DEVELOPED VOLUMES

N.T.S.

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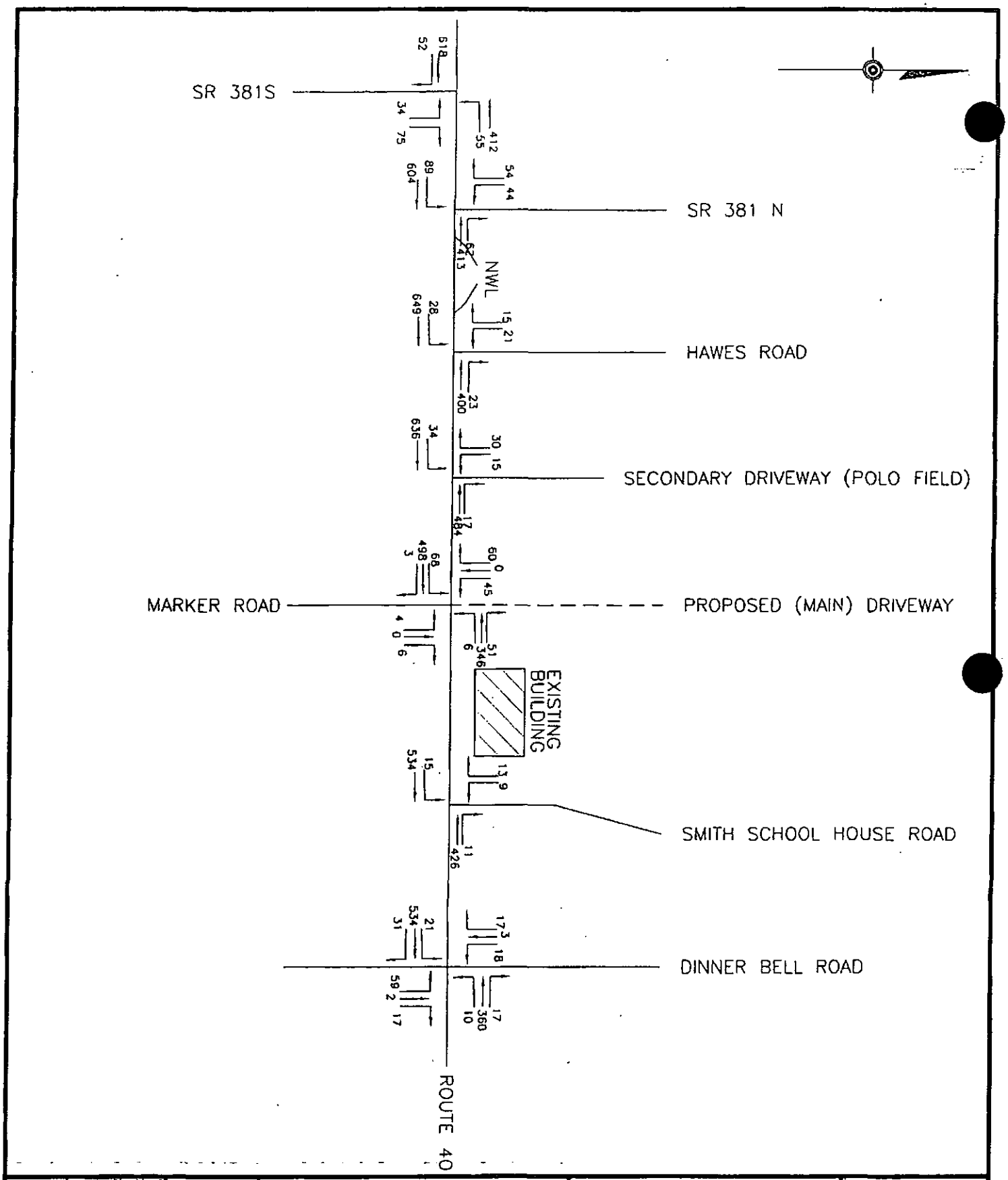

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PENNSYLVANIA

2016 SATURDAY PEAK HOUR DEVELOPED VOLUMES

FIGURE 7D

N.T.S.

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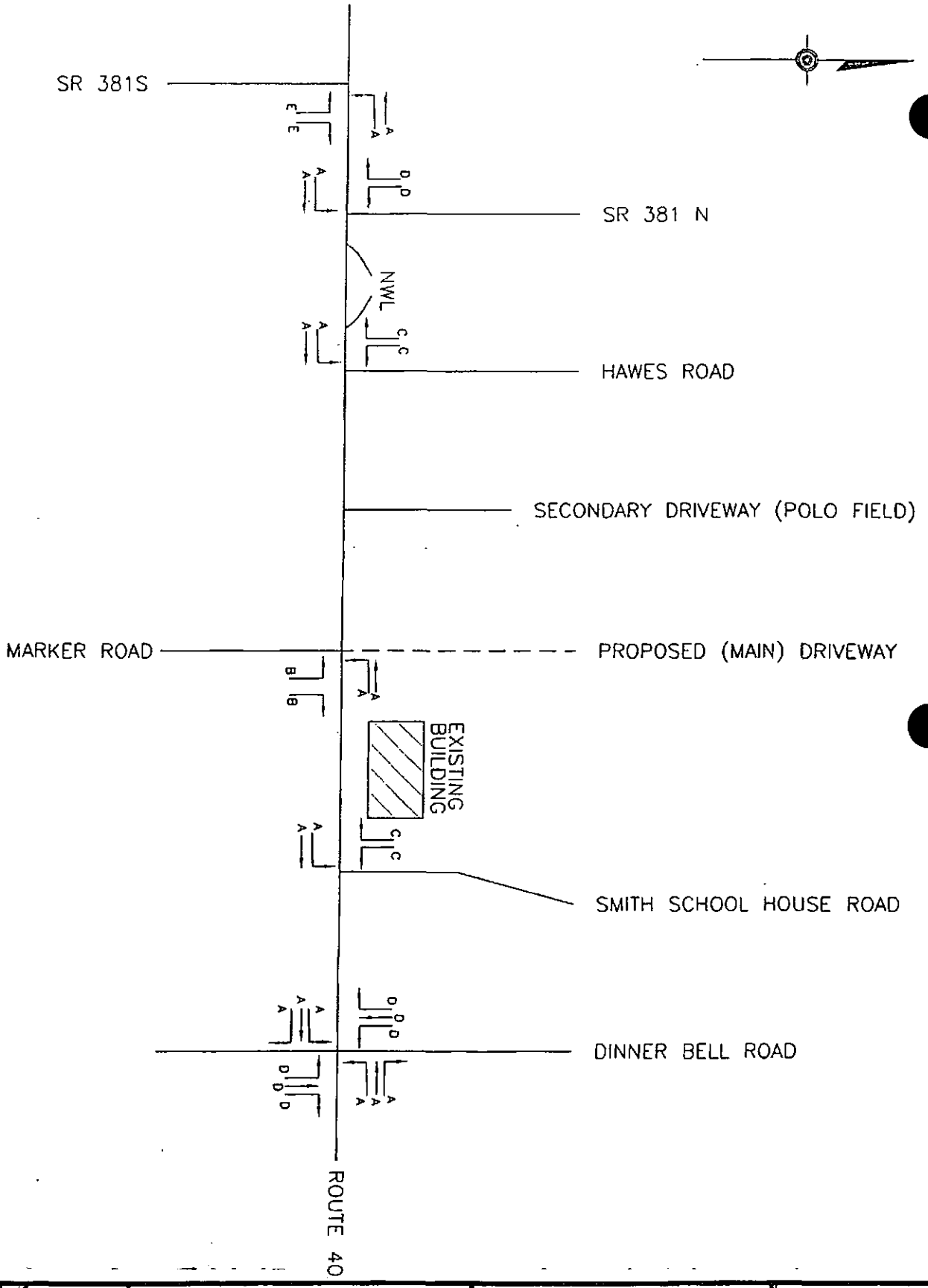

FIGURE 8A

2006 WEEKDAY PM PEAK HOUR BASE LEVEL OF SERVICE

N.T.S.

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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NWL Co.

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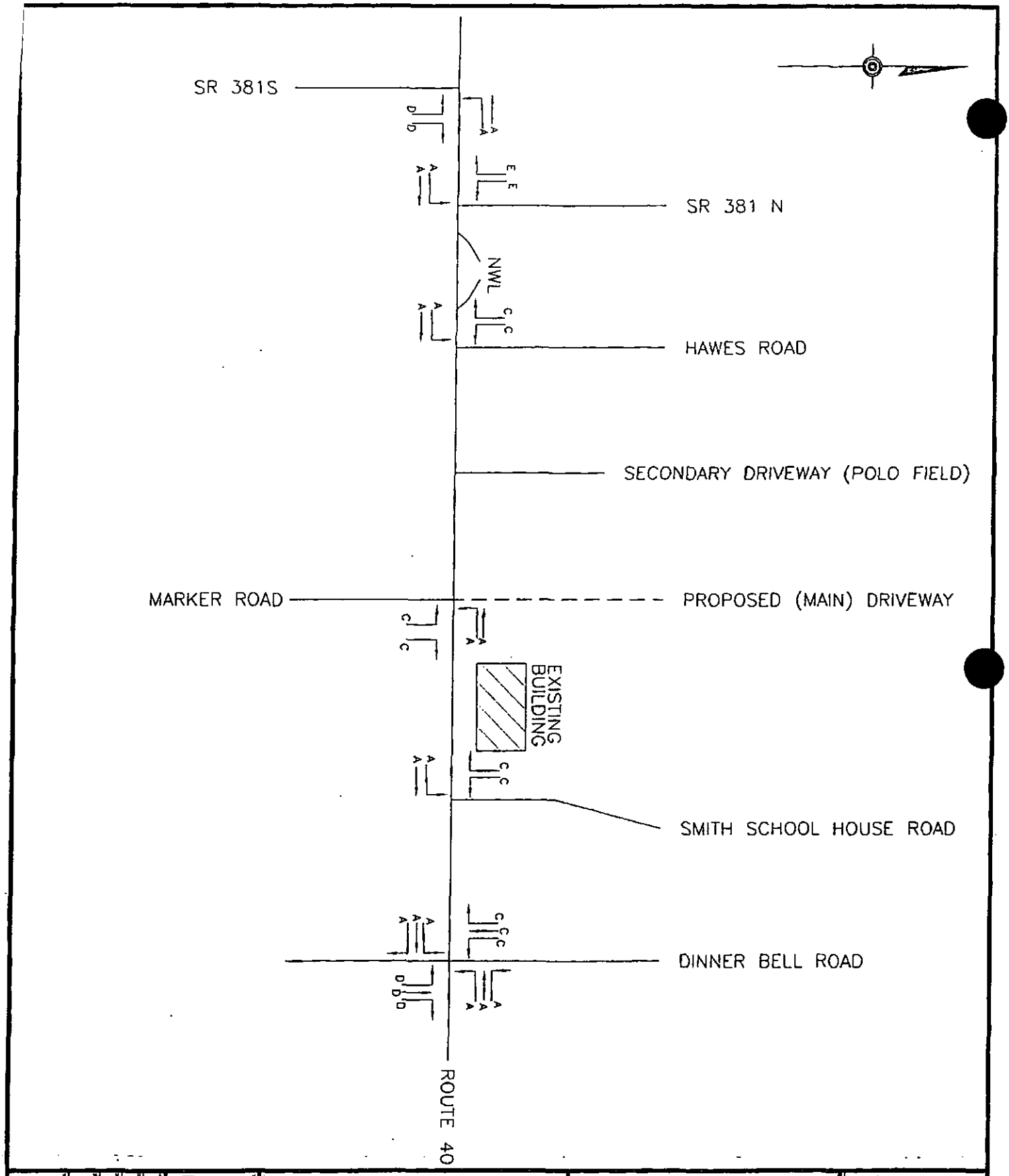

FIGURE 8B

2006 SATURDAY PEAK HOUR BASE LEVEL OF SERVICE

N.T.S.

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY

PENNSYLVANIA

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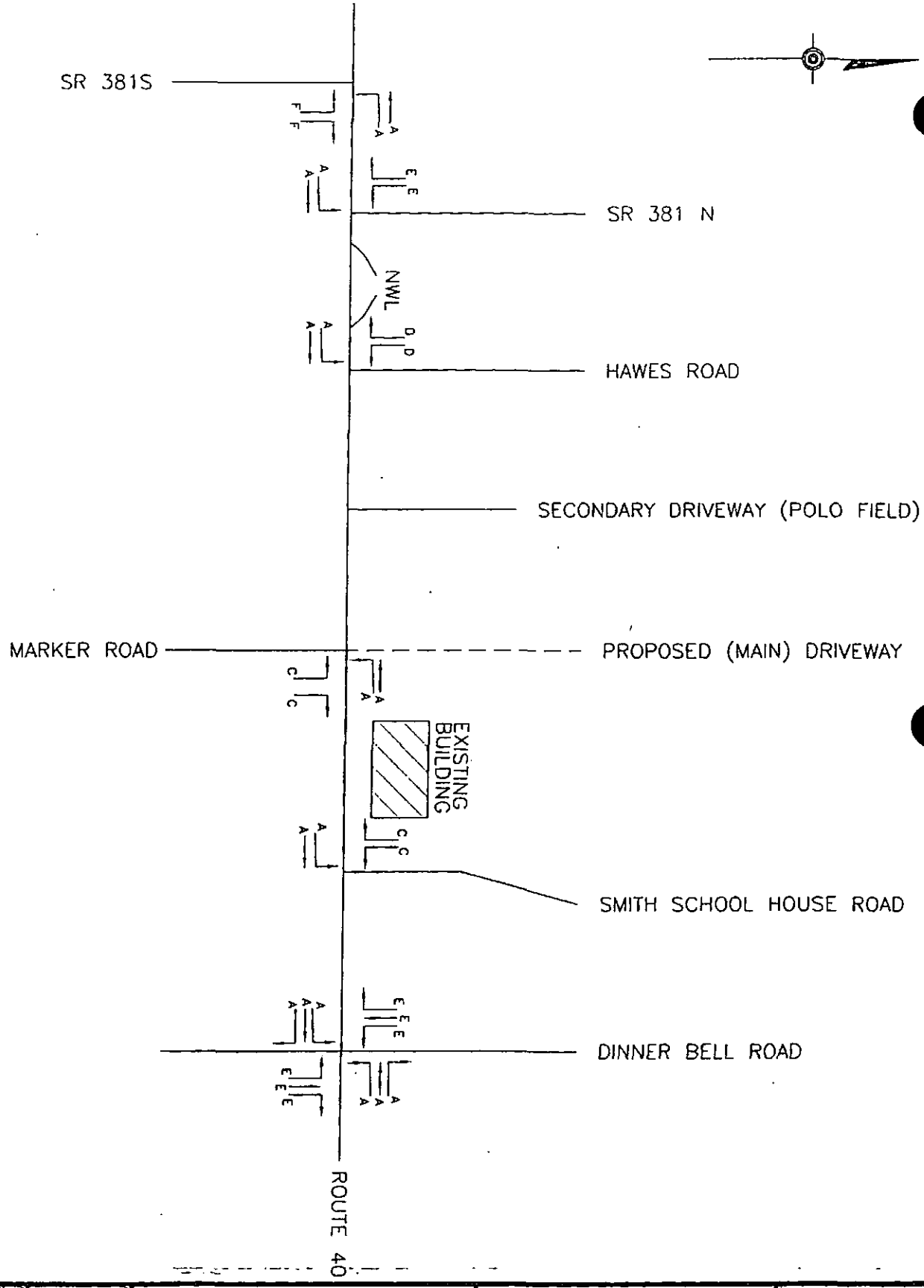

FIGURE 8C

N.T.S.

2016 WEEKDAY PM PEAK HOUR BASE LEVEL OF SERVICE

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

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WHARTON TOWNSHIP, FAYETTE COUNTY

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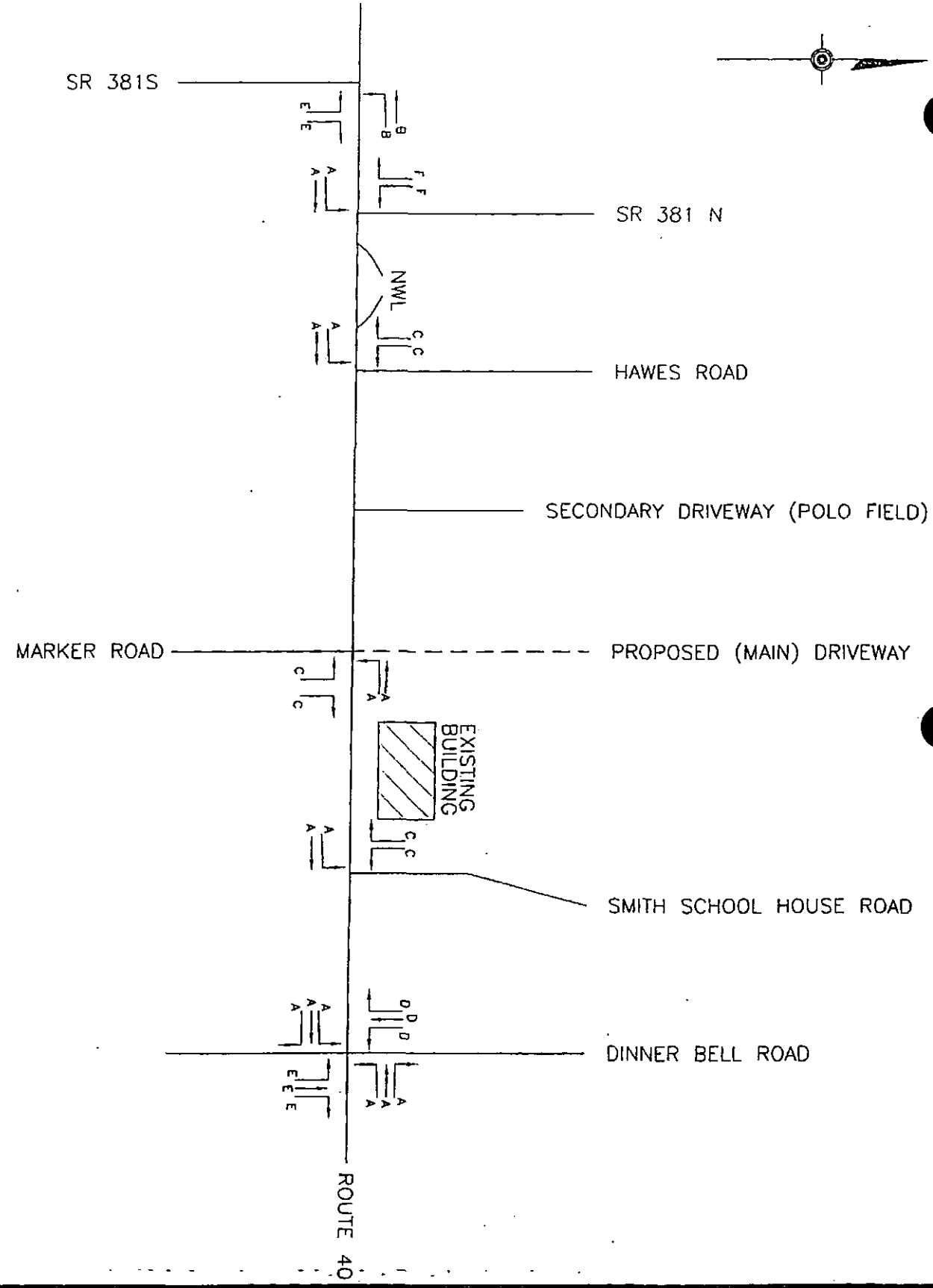

FIGURE 8D

2016 SATURDAY PEAK HOUR BASE LEVEL OF SERVICE

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY

PENNSYLVANIA

DESIGNED	RHH	11/23/03
DRAWN	RHH	11/23/03
CHECKED	TR	11/24/03
APPROVED	*	**
SCALE	N.T.S.	
JOB NO.	2005-318	
SHEET NUMBER	**	

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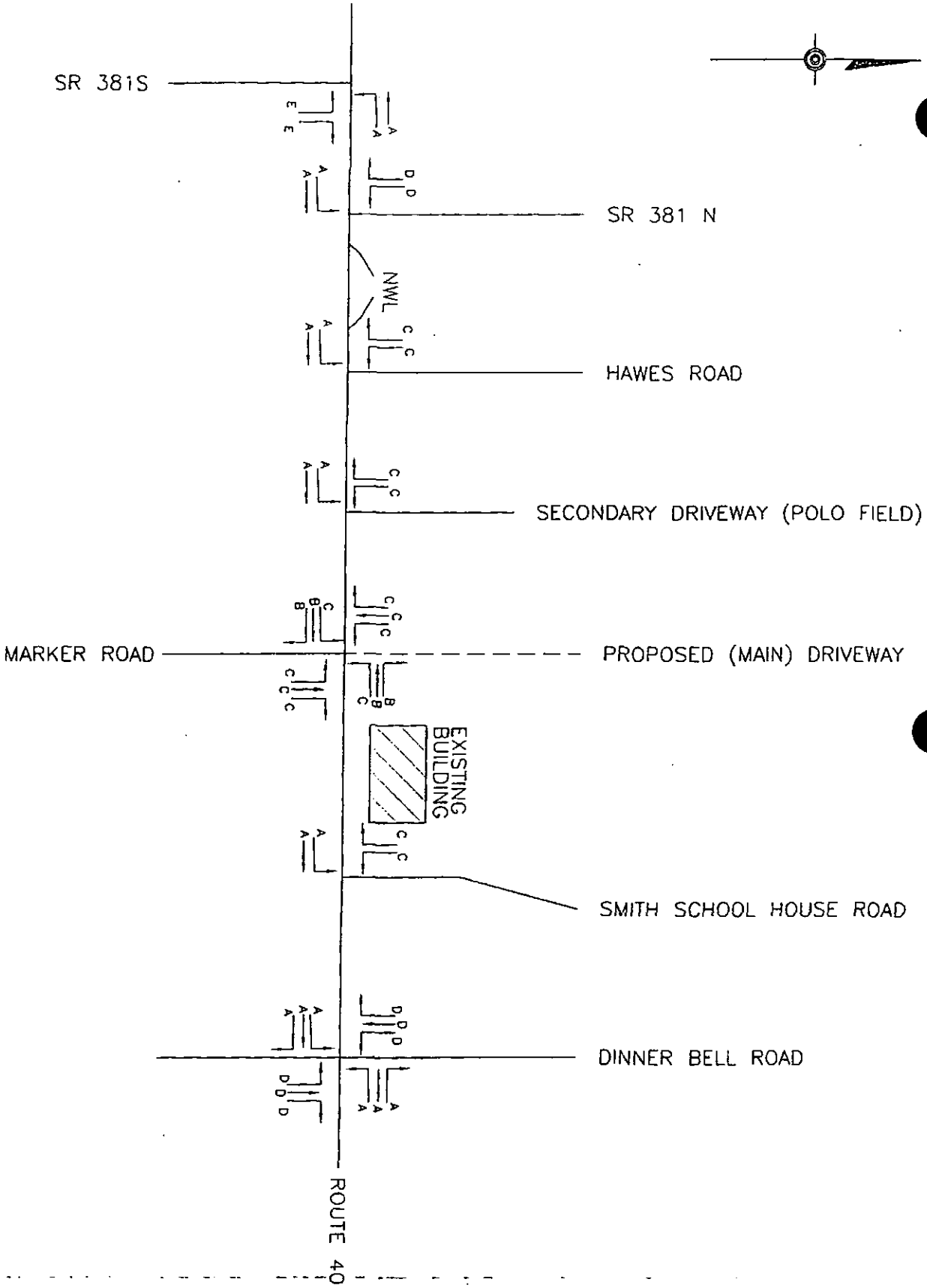

FIGURE 9A

2006 WEEKDAY PM PEAK HOUR DEVELOPED LEVEL OF SERVICE

N.T.S.

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

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Web Site www.mcmillenng.com
Email Info@mcmillenng.com

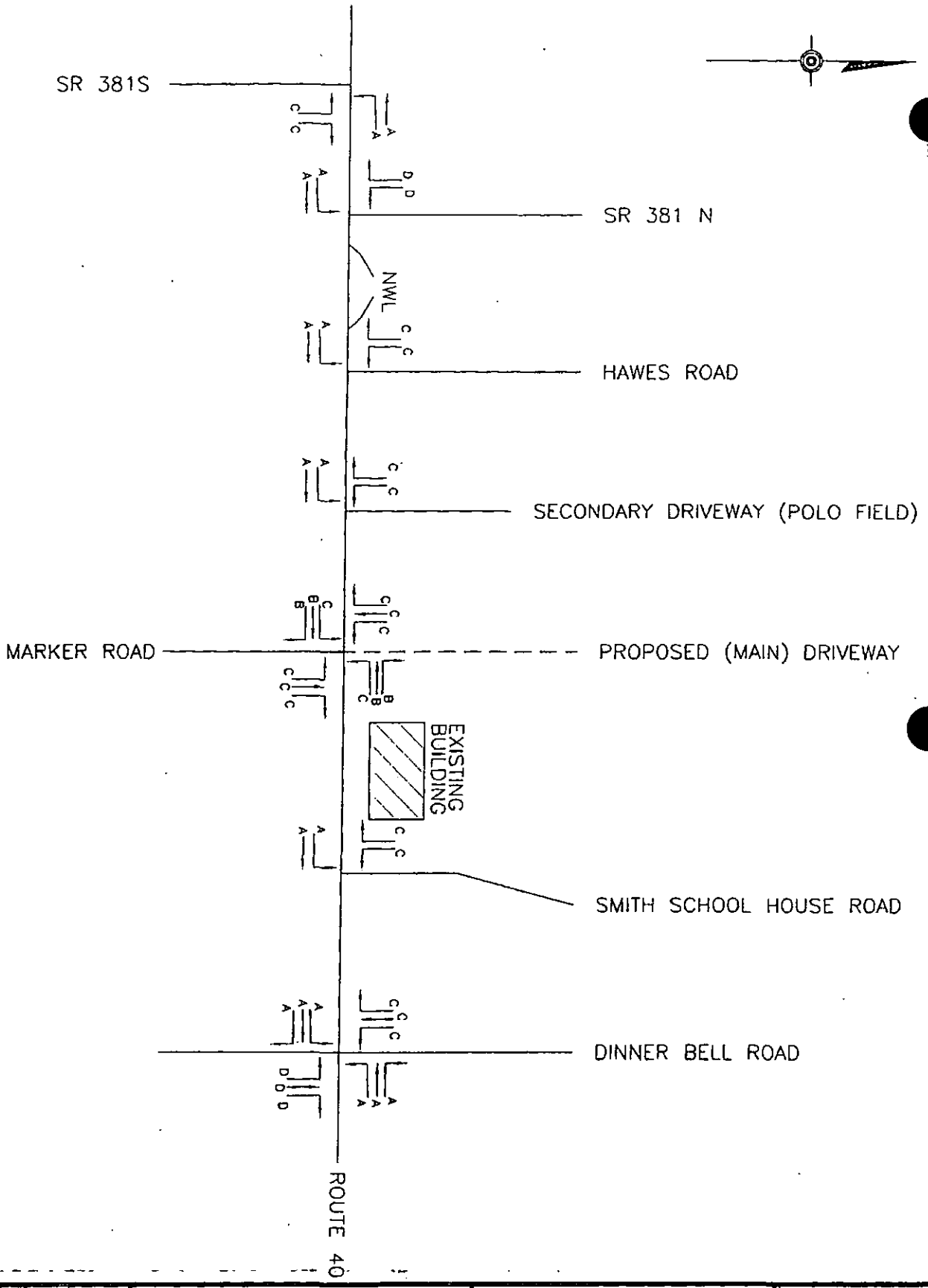

FIGURE 9B

2006 SATURDAY PEAK HOUR DEVELOPED LEVEL OF SERVICE

N.T.S.

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY

PENNSYLVANIA

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
118 Wynford Smith Drive, Uniontown, PA 15401
Phone 724-438-8110 Fax 724-438-8720
Web www.mcmillenengineering.com
Email info@mcmillenengineering.com

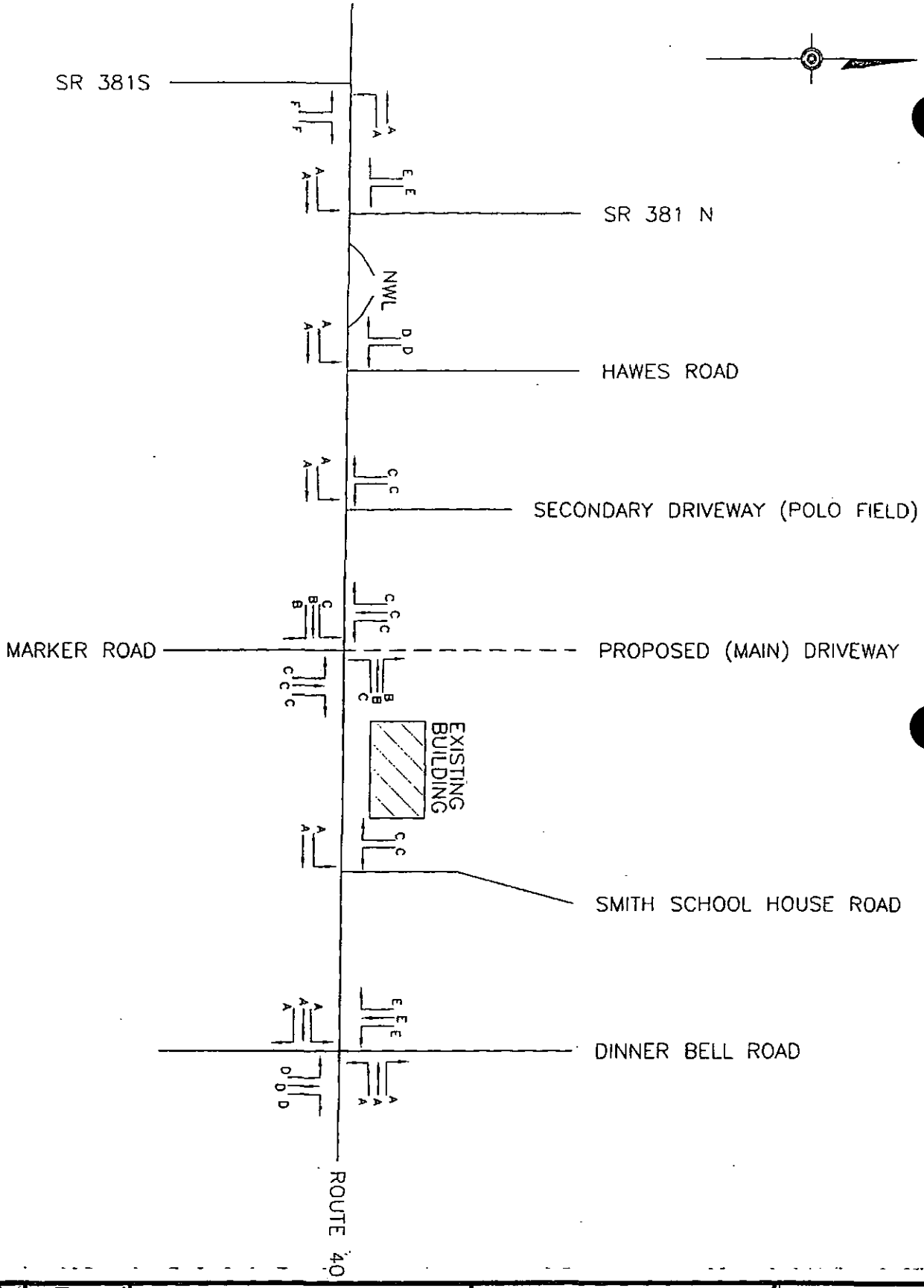

FIGURE 9C

2016 WEEKDAY PM PEAK HOUR DEVELOPED LEVEL OF SERVICE

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY

PENNSYLVANIA

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1			

G:\2005-300\2005-319\TRAFFIC\MSC\TRAFFIC STUDY

N.T.S.

2005-319

11/23/05

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CIVIL ENGINEERS
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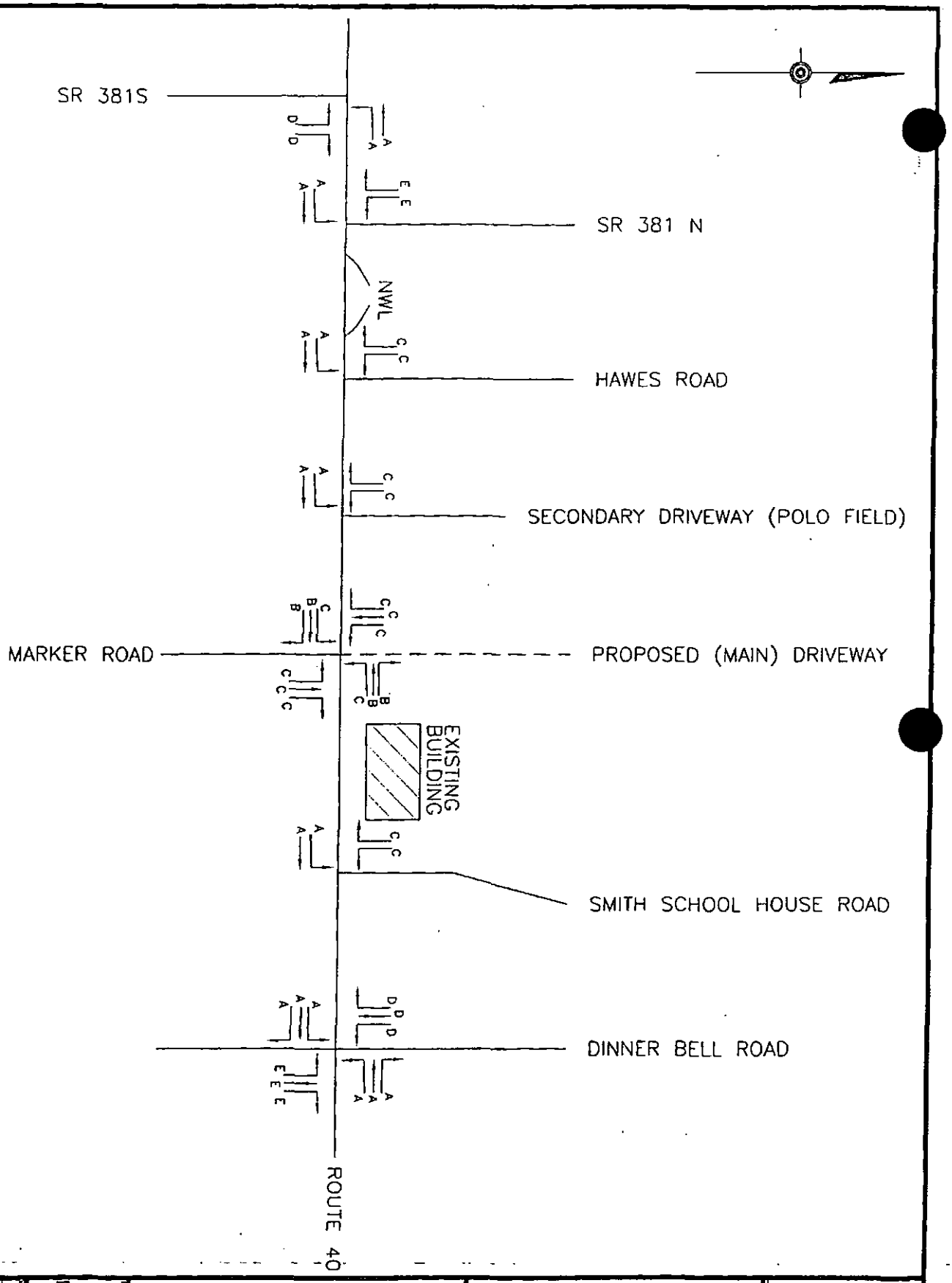

FIGURE 9D

2016 SATURDAY PEAK HOUR DEVELOPED LEVEL OF SERVICE

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY

PENNSYLVANIA

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS

APPENDIX 1

TRAFFIC COUNT DATA

NWL Outdoor Store Traffic Counts
8/12/05 and 8/13/05

Friday 8/12/05 PM

Route 40/SR 381

	Route 40 EB			SR 381 NB		SR 381 SB		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Right	Left	Thru	Right	
4:00-4:15	20	125	6	8	12	11	19	13	110	9	333
4:15-4:30	15	109	12	4	5	16	16	12	139	7	335
4:30-4:45	10	109	9	11	13	12	21	14	118	5	322
4:45-5:00	13	112	11	18	14	15	6	11	133	3	336
5:00-5:15	13	129	18	7	14	13	9	10	142	5	360
5:15-5:30	17	126	18	13	14	10	16	18	107	4	343
5:30-5:45	17	136	7	13	14	3	17	13	133	5	358
5:45-6:00	16	141	14	9	20	8	15	7	84	7	321

Route 40/Hawes Rd

	Route 40 EB			Hawes Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15	11	***	***	5	13	***	***	6	35
4:15-4:30	9			9	17			4	39
4:30-4:45	4			9	10			3	26
4:45-5:00	8			8	11			4	31
5:00-5:15	5			15	16			11	47
5:15-5:30	5			7	10			18	40
5:30-5:45	3			7	5			8	23
5:45-6:00	2			7	4			3	16

Route 40/Marker Rd

	Route 40 EB			Marker Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15		135	1	1	0	0	***		137
4:15-4:30		128	1	3	0	0			132
4:30-4:45		112	4	1	2	0			119
4:45-5:00		127	2	1	2	1			133
5:00-5:15		138	1	0	4	2			145
5:15-5:30		145	3	1	1	3			153
5:30-5:45		148	2	1	3	0			154
5:45-6:00		114	1	0	1	1			117

Route 40/Smith School House Rd

	Route 40 EB			Smith SH Rd	Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15	4	***		3	15		72	3	97
4:15-4:30	4			1	7		102	4	118
4:30-4:45	3			5	7		84	6	105
4:45-5:00	1			3	7		104	2	117
5:00-5:15	4			2	6		89	2	103
5:15-5:30	5			3	6		101	1	116
5:30-5:45	6			4	7		96	3	116
5:45-6:00	3			5	2		75	1	86

Route 40/Dinner Bell Rd

	Route 40 EB			DBR NB			DBR SB			Route 40 WB			TOTAL
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
4:00-4:15	3	***	10	7	1	1	11	0	7	3	***	6	49
4:15-4:30	6		7	4	1	3	5	2	5	6		3	42
4:30-4:45	2		9	9	0	0	6	2	1	2		2	33
4:45-5:00	2		7	3	3	5	9	0	6	2		11	48
5:00-5:15	6		14	8	1	2	7	0	2	6		10	56
5:15-5:30	2		15	7	1	6	12	1	6	2		5	57
5:30-5:45	4		11	8	2	3	8	2	1	4		12	55
5:45-6:00	2		4	6	0	3	5	0	4	2		4	30

Saturday 8/13/05

Route 40/SR 381

	Route 40 EB			SR 381 NB		SR 381 SB		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Right	Left	Thru	Right	
10:00-10:15	13	111	7	8	13	10	10	11	104	19	306
10:15-10:30	24	114	8	7	24	8	10	14	89	18	316
10:30-10:45	19	105	10	9	19	9	52	15	115	11	364
10:45-11:00	16	142	12	4	14	8	13	12	114	16	351
11:00-11:15	26	120	8	9	21	15	11	9	118	19	356
11:15-11:30	16	140	9	9	12	11	9	18	80	14	318
11:30-11:45	22	171	18	9	22	8	16	14	85	10	375
11:45-12:00	15	135	15	9	11	10	14	16	104	15	344

Route 40/Hawes Rd

	Route 40 EB			Hawes Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
10:00-10:15	6	***	***	5	2	***	***	6	19
10:15-10:30	3			0	2			10	15
10:30-10:45	11			4	4			9	28
10:45-11:00	8			5	2			9	24
11:00-11:15	2			5	6			1	14
11:15-11:30	7			6	4			6	23
11:30-11:45	8			3	2			5	18
11:45-12:00	1			5	4			5	15

Route 40/Marker Rd

	Route 40 EB			Marker Rd			Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right		Left	Thru	Right	
10:00-10:15		105	6	0	1		0	***		112
10:15-10:30		115	0	1	2		2			120
10:30-10:45		113	1	2	2		1			119
10:45-11:00		129	1	1	0		0			131
11:00-11:15		111	0	1	1		2			115
11:15-11:30		137	1	1	1		2			142
11:30-11:45		170	1	1	3		1			176
11:45-12:00		122	3	1	0		0			126

Route 40/Smith School House Rd

	Route 40 EB			Smith SH Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
10:00-10:15	2	***		0	8		94	2	106
10:15-10:30	0			3	3		93	3	102
10:30-10:45	2			1	4		122	3	132
10:45-11:00	1			3	5		114	2	125
11:00-11:15	2			5	1		109	2	119
11:15-11:30	4			0	3		89	1	97
11:30-11:45	7			0	3		86	5	101
11:45-12:00	2			2	5		92	3	104

Route 40/Dinner Bell Rd

	Route 40 EB			DBR NB			DBR SB			Route 40 WB			TOTAL
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
10:00-10:15	1	***	6	9	0	13	4	1	7	2	***	7	50
10:15-10:30	2		5	17	2	3	3	0	3	3		5	43
10:30-10:45	4		1	31	3	3	6	2	1	2		6	59
10:45-11:00	7		10	16	0	2	3	1	6	1		1	47
11:00-11:15	3		6	11	1	0	2	1	6	3		6	39
11:15-11:30	2		5	13	0	4	3	1	0	3		5	36
11:30-11:45	7		7	14	1	9	8	0	3	2		3	54
11:45-12:00	1		7	7	0	6	4	0	2	5		5	37

APPENDIX 2

CAPACITY ANALYSIS (2006 BASE CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		508	54	52	516	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR		552	72	72	567	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1 0		0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	51	0	56			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Hourly Flow Rate, HFR	71	0	56			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1 0				
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		127				
C(m) (vph)		952		232				
v/c		0.08		0.55				
95% queue length		0.24		2.96				
Control Delay		9.1		37.8				
LOS		A		E				
Approach Delay				37.8				
Approach LOS				E				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		508	54	52	516	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		138	18	18	142	
Hourly Flow Rate, HFR		552	72	72	567	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	51	0	56			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Peak-15 Minute Volume	18	0	14			
Hourly Flow Rate, HFR	71	0	56			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		567
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		624	1299	1299	588			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	588	
Potential Capacity	506	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	506	
Probability of Queue free St.	0.89	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	624	
Potential Capacity	952	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	952	
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.89	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1299	
Potential Capacity	160	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	142	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1299	
Potential Capacity	176	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.81
Movement Capacity	163	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1299	
Potential Capacity	160	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	142	
Result for 2 stage process:		
a		
y		
C t	142	
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1299	
Potential Capacity	176	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.81
Movement Capacity	163	
Results for Two-stage process:		
a		
y		
C t	163	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	71	0	56			
Movement Capacity (vph)	163	142	506			
Shared Lane Capacity (vph)		232				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	163	142	506			
Volume	71	0	56			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		232				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		127				
C(m) (vph)		952		232				
v/c		0.08		0.55				
95% queue length		0.24		2.96				
Control Delay		9.1		37.8				
OS		A		E				
Approach Delay				37.8				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(i1), Volume for stream 2 or 5		567
v(i2), Volume for stream 3 or 6		0
s(i1), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.89
d(M,LT), Delay for stream 1 or 4		9.1
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.0

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		579	47	53	397	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		689	72	71	472	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1 0			0 1	
Configuration		TR			LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	31	0	69			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Hourly Flow Rate, HFR	36	0	88			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1 0				
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		71		124				
C(m) (vph)		847		280				
v/c		0.08		0.44				
95% queue length		0.27		2.15				
Control Delay		9.6		27.7				
LOS		A		D				
Approach Delay				27.7				
Approach LOS				D				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		579	47	53	397	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		172	18	18	118	
Hourly Flow Rate, HFR		689	72	71	472	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	31	0	69			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Peak-15 Minute Volume	9	0	22			
Hourly Flow Rate, HFR	36	0	88			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		472
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)			2.20	3.50	4.00	3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)			3	3	3	3			
t(f)			2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		761	1339	1339	725			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	725	
Potential Capacity	423	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	423	
Probability of Queue free St.	0.79	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	761	
Potential Capacity	847	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	847	
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.89	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1339	
Potential Capacity	151	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	134	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1339	
Potential Capacity	167	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.92	0.72
Movement Capacity	153	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1339	
Potential Capacity		151	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.89	0.89
Movement Capacity		134	
Result for 2 stage process:			
a			
y			
C t		134	
Probability of Queue free St:		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1339	
Potential Capacity		167	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.89
Maj. L, Min T Adj. Imp Factor.			0.91
Cap. Adj. factor due to Impeding mvmnt		0.92	0.72
Movement Capacity		153	
Results for Two-stage process:			
a			
y			
C t		153	

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	36	0	88			
Movement Capacity (vph)	153	134	423			
Shared Lane Capacity (vph)		280				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	153	134	423			
Volume	36	0	88			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		280				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		71		124				
C(m) (vph)		847		280				
v/c		0.08		0.44				
95% queue length		0.27		2.15				
Control Delay		9.6		27.7				
LOS		A		D				
Approach Delay				27.7				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(il), Volume for stream 2 or 5		472
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.89
d(M,LT), Delay for stream 1 or 4		9.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/2/2005
Analysis Time Period:	Weekday PM Base
Intersection:	Route 40/SR 381 N
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2006
Project ID: Route 40 and SR 381 N	
East/West Street:	Route 40
North/South Street:	SR 381 N
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	61	503			520	17
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR	69	546			571	19
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				41	0	48
Peak Hour Factor, PHF				0.71	0.50	0.68
Hourly Flow Rate, HFR				57	0	70
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						127	
C(m) (vph)	981						274	
v/c	0.07						0.46	
95% queue length	0.23						2.30	
Control Delay	8.9						29.0	
LOS	A						D	
Approach Delay							29.0	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	61	503			520	17
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	17	137			143	5
Hourly Flow Rate, HFR	69	546			571	19
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				41	0	48
Peak Hour Factor, PHF				0.71	0.50	0.68
Peak-15 Minute Volume				14	0	18
Hourly Flow Rate, HFR				57	0	70
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	546	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	590					1264	1264	580
s								
Px								
V c,u,x								
c,x								
c plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.				9				12
Conflicting Flows								580
Potential Capacity								513
Pedestrian Impedance Factor				1.00				1.00
Movement Capacity								513
Probability of Queue free St.				1.00				0.86
Step 2: LT from Major St.				4				1
Conflicting Flows								590
Potential Capacity								981
Pedestrian Impedance Factor				1.00				1.00
Movement Capacity								981
Probability of Queue free St.				1.00				0.93
Maj L-Shared Prob Q free St.								0.90
Step 3: TH from Minor St.				8				11
Conflicting Flows								1264
Potential Capacity								169
Pedestrian Impedance Factor				1.00				1.00
Cap. Adj. factor due to Impeding mvmnt				0.90				0.90
Movement Capacity								152
Probability of Queue free St.				1.00				1.00
Step 4: LT from Minor St.				7				10
Conflicting Flows								1264
Potential Capacity								187
Pedestrian Impedance Factor				1.00				1.00
Maj. L, Min T Impedance factor				0.90				
Maj. L, Min T Adj. Imp Factor.				0.92				
Cap. Adj. factor due to Impeding mvmnt				0.80				0.93
Movement Capacity								174

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.				8				11
Part 1 - First Stage								
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor								
Cap. Adj. factor due to Impeding mvmnt								
Movement Capacity								
Probability of Queue free St.								

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1264
Potential Capacity			169
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.90	0.90
Movement Capacity			152
Result for 2 stage process:			
a			
y			
C t			152
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1264
Potential Capacity			187
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		0.90	
Maj. L, Min T Adj. Imp Factor.		0.92	
Cap. Adj. factor due to Impeding mvmnt		0.80	0.93
Movement Capacity			174
Results for Two-stage process:			
a			
y			
C t			174

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				57	0	70
Movement Capacity (vph)				174	152	513
Shared Lane Capacity (vph)					274	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				174	152	51
Volume				57	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					274	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						127	
C(m) (vph)	981						274	
v/c	0.07						0.46	
95% queue length	0.23						2.30	
Control Delay	8.9						29.0	
LOS	A						D	
Approach Delay							29.0	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.93	1.00
v(il), Volume for stream 2 or 5	546	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.9	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/2/2005
Analysis Time Period:	Saturday Peak Base
Intersection:	Route 40/SR 381 N
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2006
Project ID: Route 40 and SR 381 N	
East/West Street:	Route 40
North/South Street:	SR 381 N
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	81	567			401	59
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	89	675			477	75
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				42	0	49
Peak Hour Factor, PHF				0.70	0.50	0.77
Hourly Flow Rate, HFR				60	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						123	
C(m) (vph)	1013						237	
v/c	0.09						0.52	
95% queue length	0.29						2.72	
Control Delay	8.9						35.5	
LOS	A						E	
Approach Delay							35.5	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	81	567			401	59
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	22	169			119	19
Hourly Flow Rate, HFR	89	675			477	75
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				42	0	49
Peak Hour Factor, PHF				0.70	0.50	0.77
Peak-15 Minute Volume				15	0	16
Hourly Flow Rate, HFR				60	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	675	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	552					1367	1367	514
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		514
Potential Capacity		559
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		559
Probability of Queue free St.	1.00	0.89
Step 2: LT from Major St.	4	1
Conflicting Flows		552
Potential Capacity		1013
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1013
Probability of Queue free St.	1.00	0.91
Maj L-Shared Prob Q free St.		0.86
Step 3: TH from Minor St.	8	11
Conflicting Flows		1367
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		126
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		1367
Potential Capacity		162
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.86	
Maj. L, Min T Adj. Imp Factor.	0.89	
Cap. Adj. factor due to Impeding mvmnt	0.79	0.91
Movement Capacity		148

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1367
Potential Capacity			147
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.86	0.86
Movement Capacity			126
Result for 2 stage process:			
a			
y			
C t			126
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1367
Potential Capacity			162
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		0.86	
Maj. L, Min T Adj. Imp Factor.		0.89	
Cap. Adj. factor due to Impeding mvmnt		0.79	0.91
Movement Capacity			148
Results for Two-stage process:			
a			
y			
C t			148

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				60	0	63
Movement Capacity (vph)				148	126	559
Shared Lane Capacity (vph)					237	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				148	126	55
Volume				60	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					237	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						123	
C(m) (vph)	1013						237	
v/c	0.09						0.52	
95% queue length	0.29						2.72	
Control Delay	8.9						35.5	
LOS	A						E	
Approach Delay							35.5	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(i1), Volume for stream 2 or 5	675	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.86	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	21	524			376	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	31	569			413	56
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	0.50	0.66
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1087						347	
v/c	0.03						0.35	
95% queue length	0.09						1.54	
Control Delay	8.4						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	524			376	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	8	142			103	14
Hourly Flow Rate, HFR	31	569			413	56
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	0.50	0.66
Peak-15 Minute Volume				15	0	16
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	569	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	469					1072	1072	441
s								
Px								
V c,u,x								
r,x								
c plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage
V(c,x)								
s					1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		441
Potential Capacity		615
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		615
Probability of Queue free St.	1.00	0.90

Step 2: LT from Major St.	4	1
Conflicting Flows		469
Potential Capacity		1087
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1087
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1072
Potential Capacity		221
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		212
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1072
Potential Capacity		244
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.87	0.97
Movement Capacity		237

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1072
Potential Capacity			221
Pedestrian Impedance Factor	1.00		1.00
Cap. Adj. factor due to Impeding mvmnt	0.96		0.96
Movement Capacity			212
Result for 2 stage process:			
a			
y			
C t			212
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1072
Potential Capacity			244
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor	0.96		
Maj. L, Min T Adj. Imp Factor.	0.97		
Cap. Adj. factor due to Impeding mvmnt	0.87		0.97
Movement Capacity			237
Results for Two-stage process:			
a			
y			
C t			237

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				59	0	63
Movement Capacity (vph)				237	212	615
Shared Lane Capacity (vph)					347	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				237	212	615
Volume				59	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					347	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1087						347	
v/c	0.03						0.35	
95% queue length	0.09						1.54	
Control Delay	8.4						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	569	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/2/2005
Analysis Time Period:	Saturday Base
Intersection:	Route 40/ Hawes Road
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2006
Project ID:	Route 40 and Hawes Road
East/West Street:	Route 40
North/South Street:	Hawes Road
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	25	610			392	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	32	726			466	36
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	0.50	0.58
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	32						48	
C(m) (vph)	1057						274	
v/c	0.03						0.18	
95% queue length	0.09						0.62	
Control Delay	8.5						20.9	
OS	A						C	
Approach Delay							20.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	25	610			392	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	8	182			117	9
Hourly Flow Rate, HFR	32	726			466	36
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	0.50	0.58
Peak-15 Minute Volume				6	0	6
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	726	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	502					1274	1274	48
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.					9		12	
Conflicting Flows							484	
Potential Capacity							582	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							582	
Probability of Queue free St.					1.00		0.96	
Step 2: LT from Major St.					**4**		**1**	
Conflicting Flows							502	
Potential Capacity							1057	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							1057	
Probability of Queue free St.					1.00		0.97	
Maj L-Shared Prob Q free St.							0.95	
Step 3: TH from Minor St.					**8**		**11**	
Conflicting Flows							1274	
Potential Capacity							168	
Pedestrian Impedance Factor					1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt					0.95		0.95	
Movement Capacity							159	
Probability of Queue free St.					1.00		1.00	
Step 4: LT from Minor St.					**7**		**10**	
Conflicting Flows							1274	
Potential Capacity							185	
Pedestrian Impedance Factor					1.00		1.00	
Maj. L, Min T Impedance factor					0.95			
Maj. L, Min T Adj. Imp Factor.					0.96			
Cap. Adj. factor due to Impeding mvmnt					0.92		0.97	
Movement Capacity							179	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.					8		11	
Part 1 - First Stage								
Conflicting Flows								
otential Capacity								
Pedestrian Impedance Factor								
Cap. Adj. factor due to Impeding mvmnt								
Movement Capacity								
Probability of Queue free St.								

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1274
Potential Capacity			168
Pedestrian Impedance Factor	1.00		1.00
Cap. Adj. factor due to Impeding mvmnt	0.95		0.95
Movement Capacity			159
Result for 2 stage process:			
a			
y			
C t			159
Probability of Queue free St.	1.00		1.00
Step 4: LT from Minor St.	7		10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1274
Potential Capacity			185
Pedestrian Impedance Factor	1.00		1.00
Maj. L, Min T Impedance factor	0.95		
Maj. L, Min T Adj. Imp Factor.	0.96		
Cap. Adj. factor due to Impeding mvmnt	0.92		0.97
Movement Capacity			179
Results for Two-stage process:			
a			
y			
C t			179

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				24	0	24
Movement Capacity (vph)				179	159	582
Shared Lane Capacity (vph)					274	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				179	159	58
Volume				24	0	24
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					274	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	32						48	
C(m) (vph)	1057						274	
v/c	0.03						0.18	
95% queue length	0.09						0.62	
Control Delay	8.5						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	726	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/2/2005
Analysis Time Period:	Weekday PM Base
Intersection:	Route 40/ Marker Road
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2006
Project ID:	Route 40 and Marker/Proposed Main Driveway
East/West Street:	Route 40
North/South Street:	Marker Road
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		564	8	6	414	
Peak-Hour Factor, PHF		0.94	0.67	0.50	0.94	
Hourly Flow Rate, HFR		600	11	12	440	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1 0		0 1		
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	3	0	10			
Peak Hour Factor, PHF	0.75	0.50	0.62			
Hourly Flow Rate, HFR	4	0	16			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1 0				
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		12		20				
C(m) (vph)		963		409				
v/c		0.01		0.05				
95% queue length		0.04		0.15				
Control Delay		8.8		14.3				
OS		A		B				
Approach Delay				14.3				
Approach LOS				B				

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		564	8	6	414	
Peak-Hour Factor, PHF		0.94	0.67	0.50	0.94	
Peak-15 Minute Volume		150	3	3	110	
Hourly Flow Rate, HFR		600	11	12	440	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	3	0	10			
Peak Hour Factor, PHF	0.75	0.50	0.62			
Peak-15 Minute Volume	1	0	4			
Hourly Flow Rate, HFR	4	0	16			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		440
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)			2.20	3.50	4.00	3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)			3	3	3	3			
t(f)			2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		611	1070	1070	606			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s	1500		1500					
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	606	
Potential Capacity	496	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	496	
Probability of Queue free St.	0.97	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	611	
Potential Capacity	963	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	963	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.98	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1070	
Potential Capacity	221	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	217	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1070	
Potential Capacity	244	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.96
Movement Capacity	241	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1070	
Potential Capacity		221	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.98	0.98
Movement Capacity		217	
Result for 2 stage process:			
a			
y			
C t		217	
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1070	
Potential Capacity		244	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.98
Maj. L, Min T Adj. Imp Factor.			0.99
Cap. Adj. factor due to Impeding mvmnt		0.99	0.96
Movement Capacity		241	
Results for Two-stage process:			
a			
y			
C t		241	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	16			
Movement Capacity (vph)	241	217	496			
Shared Lane Capacity (vph)		409				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	241	217	496			
Volume	4	0	16			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		409				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		12		20				
C(m) (vph)		963		409				
v/c		0.01		0.05				
95% queue length		0.04		0.15				
Control Delay		8.8		14.3				
LOS		A		B				
Approach Delay				14.3				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		440
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		8.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/2/2005
Analysis Time Period:	Saturday Base
Intersection:	Route 40/ Marker Road
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2006
Project ID:	Route 40 and Marker/Proposed Main Driveway
East/West Street:	Route 40
North/South Street:	Marker Road
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		552	3	5	409	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Hourly Flow Rate, HFR		689	4	8	470	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	0	5			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Hourly Flow Rate, HFR	4	0	11			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		8		15				
C(m) (vph)		898		341				
v/c		0.01		0.04				
95% queue length		0.03		0.14				
Control Delay		9.0		16.0				
LOS		A		C				
Approach Delay				16.0				
Approach LOS				C				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		552	3	5	409	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Peak-15 Minute Volume		172	1	2	118	
Hourly Flow Rate, HFR		689	4	8	470	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	4	0	5			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Peak-15 Minute Volume	1	0	3			
Hourly Flow Rate, HFR	4	0	11			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		470
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)			2.20	3.50	4.00	3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)			3	3	3	3			
t(f)			2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		693	1177	1177	691			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s	1500		1500					
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	691	
Potential Capacity	443	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	443	
Probability of Queue free St.	0.98	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	693	
Potential Capacity	898	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	898	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1177	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	189	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1177	
Potential Capacity	211	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.97
Movement Capacity	209	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1177	
Potential Capacity		191	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.99	0.99
Movement Capacity		189	
Result for 2 stage process:			
a			
y			
C t		189	
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1177	
Potential Capacity		211	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.99
Maj. L, Min T Adj. Imp Factor.			0.99
Cap. Adj. factor due to Impeding mvmnt		0.99	0.97
Movement Capacity		209	
Results for Two-stage process:			
a			
y			
C t		209	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	11			
Movement Capacity (vph)	209	189	443			
Shared Lane Capacity (vph)		341				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	209	189	443			
Volume	4	0	11			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		341				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		8		15				
C(m) (vph)		898		341				
v/c		0.01		0.04				
95% queue length		0.03		0.14				
Control Delay		9.0		16.0				
LOS		A		C				
Approach Delay				16.0				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		470
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.99
d(M,LT), Delay for stream 1 or 4		9.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	16	558			394	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	23	593			419	11
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.38	0.93
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1124						392	
v/c	0.02						0.11	
95% queue length	0.06						0.37	
Control Delay	8.3						15.3	
OS	A						C	
Approach Delay							15.3	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	16	558			394	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	6	148			105	3
Hourly Flow Rate, HFR	23	593			419	11
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.38	0.93
Peak-15 Minute Volume				4	0	7
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	593	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	430					1063	1063	424
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9			12		
Conflicting Flows						424		
Potential Capacity						627		
Pedestrian Impedance Factor			1.00			1.00		
Movement Capacity						627		
Probability of Queue free St.			1.00			0.96		
Step 2: LT from Major St.			**4**			**1**		
Conflicting Flows						430		
Potential Capacity						1124		
Pedestrian Impedance Factor			1.00			1.00		
Movement Capacity						1124		
Probability of Queue free St.			1.00			0.98		
Maj L-Shared Prob Q free St.						0.97		
Step 3: TH from Minor St.			**8**			**11**		
Conflicting Flows						1063		
Potential Capacity						221		
Pedestrian Impedance Factor			1.00			1.00		
Cap. Adj. factor due to Impeding mvmnt			0.97			0.97		
Movement Capacity						214		
Probability of Queue free St.			1.00			1.00		
Step 4: LT from Minor St.			**7**			**10**		
Conflicting Flows						1063		
Potential Capacity						245		
Pedestrian Impedance Factor			1.00			1.00		
Maj. L, Min T Impedance factor			0.97					
Maj. L, Min T Adj. Imp Factor.			0.98					
Cap. Adj. factor due to Impeding mvmnt			0.93			0.98		
Movement Capacity						240		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.			8			11		
Part 1 - First Stage								
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor								
Cap. Adj. factor due to Impeding mvmnt								
Movement Capacity								
Probability of Queue free St.								

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1063
Potential Capacity			221
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.97	0.97
Movement Capacity			214
Result for 2 stage process:			
a			
y			
C t			214
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1063
Potential Capacity			245
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		0.97	
Maj. L, Min T Adj. Imp Factor.		0.98	
Cap. Adj. factor due to Impeding mvmnt		0.93	0.98
Movement Capacity			240
Results for Two-stage process:			
a			
y			
C t			240

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16	0	27
Movement Capacity (vph)				240	214	627
Shared Lane Capacity (vph)					392	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				240	214	62
Volume				16	0	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					392	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1124						392	
v/c	0.02						0.11	
95% queue length	0.06						0.37	
Control Delay	8.3						15.3	
LOS	A						C	
Approach Delay							15.3	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(i1), Volume for stream 2 or 5	593	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	14	504			402	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	28	579			462	20
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.38	0.60
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1075						325	
v/c	0.03						0.12	
95% queue length	0.08						0.39	
Control Delay	8.4						17.5	
LOS	A						C	
Approach Delay							17.5	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	14	504			402	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	7	145			116	5
Hourly Flow Rate, HFR	28	579			462	20
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.38	0.60
Peak-15 Minute Volume				5	0	5
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	579	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	482					1107	1107	472
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.					9		12	
Conflicting Flows							472	
Potential Capacity							589	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							589	
Probability of Queue free St.					1.00		0.97	

Step 2: LT from Major St.					4		1	
Conflicting Flows							482	
Potential Capacity							1075	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							1075	
Probability of Queue free St.					1.00		0.97	
Maj L-Shared Prob Q free St.							0.96	

Step 3: TH from Minor St.					8		11	
Conflicting Flows							1107	
Potential Capacity							208	
Pedestrian Impedance Factor					1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt					0.96		0.96	
Movement Capacity							200	
Probability of Queue free St.					1.00		1.00	

Step 4: LT from Minor St.					7		10	
Conflicting Flows							1107	
Potential Capacity							230	
Pedestrian Impedance Factor					1.00		1.00	
Maj. L, Min T Impedance factor					0.96			
Maj. L, Min T Adj. Imp Factor.					0.97			
Cap. Adj. factor due to Impeding mvmnt					0.94		0.97	
Movement Capacity							224	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.					8		11	
Part 1 - First Stage								
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor								
Cap. Adj. factor due to Impeding mvmnt								
Movement Capacity								
Probability of Queue free St.								

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1107
Potential Capacity			208
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.96	0.96
Movement Capacity			200
Result for 2 stage process:			
a			
y			
C t			200
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			1107
Potential Capacity			230
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		0.96	
Maj. L, Min T Adj. Imp Factor.		0.97	
Cap. Adj. factor due to Impeding mvmnt		0.94	0.97
Movement Capacity			224
Results for Two-stage process:			
a			
y			
C t			224

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				19	0	19
Movement Capacity (vph)				224	200	58
Shared Lane Capacity (vph)					325	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				224	200	58
Volume				19	0	19
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					325	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1075						325	
v/c	0.03						0.12	
95% queue length	0.08						0.39	
Control Delay	8.4						17.5	
LOS	A						C	
Approach Delay							17.5	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(i1), Volume for stream 2 or 5	579	
v(i2), Volume for stream 3 or 6	0	
s(i1), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	26	508	47	14	360	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR	32	540	60	24	382	48
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage		No /			No /	
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1124	972		224			210	
v/c	0.03	0.02		0.30			0.37	
95% queue length	0.09	0.08		1.21			1.61	
Control Delay	8.3	8.8		27.8			31.9	
LOS	A	A		D			D	
Approach Delay				27.8			31.9	
Approach LOS				D			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	26	508	47	14	360	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	8	135	15	6	96	12
Hourly Flow Rate, HFR	32	540	60	24	382	48
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	8	3	6	12	2	6
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	540	382
Shared ln volume, major rt vehicles:	60	48
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	3	3	3	3	3	3	3	3
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	430	600	1103	1112	570	1106	1118	40
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s	1500		1500		1500			1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	570	406
Potential Capacity	519	643
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	519	643
Probability of Queue free St.	0.96	0.96
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	600	430
Potential Capacity	972	1124
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	972	1124
Probability of Queue free St.	0.98	0.97
Maj L-Shared Prob Q free St.	0.97	0.96
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows	1112	1118
Potential Capacity	208	206
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	193	191
Probability of Queue free St.	0.94	0.96
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows	1103	1106
Potential Capacity	188	187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.88	0.86
Movement Capacity	166	161

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1112	1118
Potential Capacity	208	206
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	193	191
Result for 2 stage process:		
a		
y		
C t	193	191
Probability of Queue free St.	0.94	0.96
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1103	1106
Potential Capacity	188	187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.88	0.86
Movement Capacity	166	161
Results for Two-stage process:		
a		
y		
C t	166	161

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	32	12	23	48	7	23
Movement Capacity (vph)	166	193	519	161	191	64
Shared Lane Capacity (vph)		224			210	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	166	193	519	161	191	64
Volume	32	12	23	48	7	23
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		224			210	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1124	972		224			210	
v/c	0.03	0.02		0.30			0.37	
95% queue length	0.09	0.08		1.21			1.61	
Control Delay	8.3	8.8		27.8			31.9	
LOS	A	A		D			D	
Approach Delay				27.8			31.9	
Approach LOS				D			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	*Movement 5*
p(oj)	0.97	0.98
v(i1), Volume for stream 2 or 5	540	382
v(i2), Volume for stream 3 or 6	60	48
s(i1), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.97
d(M,LT), Delay for stream 1 or 4	8.3	8.8
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	19	504	28	9	342	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	25	579	44	13	393	21
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage		No /			No /	
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1140	953		225			240	
v/c	0.02	0.01		0.46			0.25	
95% queue length	0.07	0.04		2.21			0.96	
Control Delay	8.2	8.8		33.8			24.9	
LOS	A	A		D			C	
Approach Delay				33.8			24.9	
Approach LOS				D			C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	19	504	28	9	342	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	6	145	11	3	98	5
Hourly Flow Rate, HFR	25	579	44	13	393	21
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	16	1	9	8	1	6
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage		No	/			No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	579	393
Shared ln volume, major rt vehicles:	44	21
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(i,prot)	V(t)	V(i,prot
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	414	623	1095	1091	601	1100	1103	40
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stag
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	601	404
Potential Capacity	499	644
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	499	644
Probability of Queue free St.	0.93	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	623	414
Potential Capacity	953	1140
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	953	1140
Probability of Queue free St.	0.99	0.98
Maj L-Shared Prob Q free St.	0.98	0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows	1091	1103
Potential Capacity	214	210
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	203	199
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10
Conflicting Flows	1095	1100
Potential Capacity	191	188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.91	0.88
Movement Capacity	174	166

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1091	1103
Potential Capacity	214	210
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	203	199
Result for 2 stage process:		
a		
y		
C t	203	199
Probability of Queue free St.	0.98	0.98
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
'art 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1095	1100
Potential Capacity	191	188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.91	0.88
Movement Capacity	174	166
Results for Two-stage process:		
a		
y		
C t	174	166

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	64	4	35	32	4	24
Movement Capacity (vph)	174	203	499	166	199	64
Shared Lane Capacity (vph)		225			240	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12
C sep	174	203	499	166	199	6
Volume	64	4	35	32	4	2
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		225			240	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1140	953		225			240	
v/c	0.02	0.01		0.46			0.25	
95% queue length	0.07	0.04		2.21			0.96	
Control Delay	8.2	8.8		33.8			24.9	
LOS	A	A		D			C	
Approach Delay				33.8			24.9	
Approach LOS				D			C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	0.99
v(il), Volume for stream 2 or 5	579	393
v(i2), Volume for stream 3 or 6	44	21
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.97	0.98
d(M,LT), Delay for stream 1 or 4	8.2	8.8
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2